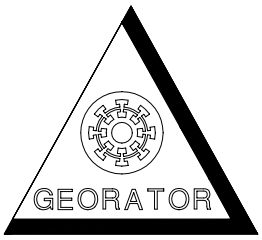

BELT COUPLED MOTOR – GENERATOR SETS

GENERAL USER'S MANUAL

MOTOR – GENERATOR SETS

WARNING

DO NOT LIFT THE UNIT WITH LIFTING EYE BOLTS ON GENERATOR AND MOTOR. USE 2” DIAMETER HOLES PROVIDED IN THE BASE

DANGER

HIGH VOLTAGE

CAUTION - CONNECT EQUIPMENT GROUND TO GROUND STUD AND INSULATE LEAD TERMINALS BEFORE STARTING THE GENERATOR. FAILURE TO COMPLY MAY RESULT IN ELECTRICAL SHOCK AND DAMAGE TO THE UNIT

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MOTOR MANUAL

GENERATOR MANUAL

VOLTAGE REGULATOR MANUAL

OUTPUT CIRCUIT BREAKER MANUAL

OUTPUT METER PACKAGE MANUAL

BELT COUPLED MOTOR-GENERATOR SETS
GENERAL INSTRUCTIONS

1.0 Georator Motor Generator (MG) Sets are inspected and fully tested at the factory before shipping. Tests specifically conducted are:

- 1.1 Examination of both motor and generator for general operation, vibration and noise.
- 1.2 Check of the output voltage of the generator, and the setting of voltage regulator adjustments to the required output voltage.
- 1.3 Check of the output frequency of the generator at no load. If the frequency is not within standard limits called for in the specifications, pulleys are turned (machined) to provide the correct frequency output. The unit will then be re-tested.
- 1.4 Motor starter operation is checked. Overload relay is tested.
- 1.5 Meters are checked for general operation, and calibrated if necessary.
- 1.6 Tripping function of the circuit breaker is checked using the test button.

2.0 Users should follow national, local, and site codes for wiring, protection, and installation. No holes are punched in either Motor Starter enclosure or Generator connection box for electrical connections. The user should place these holes where most convenient for the installation.

3.0 In selecting a location for the Motor-Generator Set, consideration should be given to environment and ventilation. Do not obstruct air flow for air intake and exhaust of the motor, generator, and pulleys & belts, or coupling. Allow a distance of at least 3 feet around the perimeter of the unit. Restricted ventilation will cause a motor-generator to operate at higher than desired temperature. Dirt, dust, chemicals, snow, oil, grass, weeds, etc., all can clog passages of an open frame motor. Georator uses open drip proof motors and generators, with drip covers, as a standard. Open drip proof construction is intended for use indoors where the atmosphere is relatively clean, dry and non-corrosive. According to the NEMA MG-2 publication, a drip proof machine is “an open machine in which the ventilating openings are so constructed that successful operation is not interfered with when drops of liquid or solid particles strike or enter the enclosure at any angle from 0 to 15 degrees, downward from the vertical”. Optional weather protection enclosures may be provided for outdoor installation. See paragraph 12, below, for a description of optional enclosures.

4.0 Ambient temperature of the air surrounding the MG Set should not exceed 40°C (104°F), for standard rated motors and generators. De-rating may be necessary if the ambient temperature exceeds 40°C. Consult Georator engineering for recommendations. For estimated values of heat generated by the MG set under full-load conditions (BTU/hr) please consult Georator engineering.

5.0 Eyebolts or lifting lugs on the motor or the generator are intended only for lifting the motor or generator. These lifting provisions should never be used to handle the entire MG Set. Please use the holes provided in the base for lifting the entire assembly.

6.0 The MG Set base should be mounted on level, solid foundation. Georator recommends using the 4 mounting holes in the base for mounting the base directly on a rigid foundation. If these holes are used, 5/8" bolts will be required for mounting. For mounting the unit on a concrete foundation , anchored bolts can be used with a maximum nut torque of approx. 30 lb-ft. Anchored bolts can pull loose if the concrete is overstressed by too much bolt tension. If grouting is used, always check for cracks and gaps.

7.0 All rotating parts such as couplings, pulleys, and unused shaft extensions are guarded in accordance with ANSIB15.1. Welded steel guards are provided on all MG sets. Belt guard screens are welded in the front end of the belt guards for ventilation and should not be obstructed.

8.0 Excessive Vibration may be the result of:

- 8.1 Un-even mounting surface.
- 8.2 Non rigid mounting surface, or loose mounting bolt(s).
- 8.3 For coupled-in-line units, coupling misalignment.
- 8.4 Belt tension and alignment (please refer to the belt tensioning and maintenance section of the service manual).
- 8.5 Inherent vibration in either motor or generator, or both. This vibration may occur as a result of worn bearings, or an unbalanced rotor.
- 8.6 For belted units, improper balance on the either, or both, sheaves.

9.0 Audible Noise: Belted motor-generator sets are typically louder than coupled-in-line motor-generator sets. Indoor installation sites requires consideration for the noise level that the set is likely to produce. As far as speech interference is concerned, maximum levels recommended for offices are 60-65 dB. For belted units, an estimate for Georator's MG sets sound pressure level is dB 75-85 dB at 3 feet. This level may vary under given operating and environment conditions and is expected to be maximum when the MG set is operating under full load condition, and near a corner with poor sound absorbing reflective surfaces. It will be even higher than the above levels with abnormal vibration conditions caused by loose belts. A rigid sealed enclosure, with baffles, reduces noise levels typically by 15-25 dB. Although typical sound attenuating enclosures offered by Georator are not sealed at the bottom, careful design of the enclosure, baffles, and

inclusion of acoustical absorbing materials substantially reduce the audible noise of the MG by typically 25-30 dB at 3 feet.

10.0 Electrical Considerations:

10.1 Apply the correct input voltage to the Motor Starter terminals. Motors may operate within ±10% of their nameplate; however performance characteristics will differ from nameplate data. Maximum frequency variation may not exceed ±5% rated frequency. Good electrical systems and operating practice limit the voltage at the motor under load to not more than ±5% of nameplate. Also note that starting motors at lower input voltages will reduce the starting torque, thereby prolonging the acceleration time of the motor from stand still (locked rotor) to rated speed. With MG Sets, the motor is already started under some load, which is the generator's inertia. For full voltage starting, the maximum allowable time for small frame motors (up to 286T) is 10 seconds, for medium frames (324T-326T) is 15 seconds, and for large frames (364T-449T) is 15 seconds.

10.2 To prevent nuisance tripping when starting the unit, ensure that an appropriately sized circuit breaker is used with the instantaneous trip set at least at 800% of the Full Load Amp of the motor (per NEC Table 430-152). Typical locked rotor current (for across the line start) can be as high as 600% to 800% of full load motor amps (FLA). Georator offers reduced voltage motor starters as a standard for units using 125 HP motors and above. Part winding motor starters can reduce the starting current by 50%, whereas Wye/Delta motor starters can reduce starting current down to 33% of the normal starting current. Solid-State Soft Starters can significantly reduce the starting current of the motor to a controlled level usually selected by the user in the range of 25% - 55% of the motor full load current.

10.3 All motors used on Georator MG sets confirm with the EPACT mandate requirements for high efficiency induction motors.

10.4 Check input voltage periodically. Voltage imbalances cause temperature rise in the motor. A 3.5% voltage imbalance will typically cause 25% temperature rise in the motor.

10.5 The Neutral wire on the Generator side is provided for most wiring configurations for three phase Wye, and single phase Delta or Zig-Zag connections. The Neutral wire – if provided – is not tied to the ground potential in the factory. User to follow the installation requirements and codes pertaining to grounding. Except in the case of MG Sets designed for special testing requirements with complete isolation of Input and Output, the structural steel base is electrically bonded to the motor and generator frames through the mounting bolts of each, thus confirming to NEC Article 250-104 (d). Other applicable standards for grounding are:

10.5.1 NEC, Article 430, Part L on grounding of motors.

10.5.2 NEC, Article 445-1 on grounding of generators.

10.5.3 NEC, Article 250 for general information on grounding.

11.0 Optional Accessories: Several control and protection accessories are provided with the MG sets. Below is a description of each. Other devices may also be provided to facilitate special testing or operational requirements. Consult with Georator Application Engineers.

11.1 Motor Starters: Starters used are generally Enclosed, Full Voltage, Magnetic, Non-Reversing, with IEC Rated contacts. Non-combination (without Input Circuit Breakers) starters are offered as a standard. Enclosures are NEMA1 Type. Combination Motor Starters and different type enclosures, e.g., dust tight, can also be provided. All starters are supplied with motor overload Class 10 protection. This protection is a solid state relay with wide selection of motor current and manual trip reset. Door mounted Start/Stop push buttons are also provided. Additional auxiliary contacts, and/or power control transformers can also be made available for control purposes. Reduced voltage starters are the general offering for large motors.

11.2 Circuit Breakers: Breakers are Thermal-Magnetic Trip, Molded Case, 2 or 3 pole Common Trip circuit breakers. A molded circuit breaker is one that is assembled as an integral unit in a supportive and enclosing housing of insulating material. The circuit breakers offered by Georator are provided for the output (generator) and are wired to the generator terminals and mounted on the generator connection box. They are supplied complete with line and load terminals, and in the case of FD Frames (250 Amp frames) and above the Breaker is UL listed for reverse feed applications. For FD Frames and up, an adjustable magnetic trip unit is provided. In addition to providing short circuit protection (through the magnetic trip unit), and an overload protection (through the thermal trip unit), the circuit breakers are often used, as convenient switches, to apply the “Load” to the Generator terminals. Several accessories and modifications may optionally be provided with the circuit breakers such as Shunt trip devices, under-voltage release, and auxiliary switches. For “Safety and Installation Instructions”, the user should consult the appropriate section of the service manual. For general information on application and performance refer to NEMA Standards Publications AB 1 and AB 3. For Guidelines for Inspection and preventive maintenance consult NEMA AB 4.

11.3 Power Monitor: The power monitor is a solid-state digital triple display multi-function power monitoring system. The power monitor simultaneously displays every metered electrical power function including:

11.3.1 Volts,
11.3.2 Amps,
11.3.3 Frequency,
11.3.4 KW or KVA

The Meter is featured with a large bright digital display and a smart keypad for programming and calibration. The meter can also be supplied with digital communications interface port such as RS232 or RS485 that allows it to interface with other equipment and allow remote monitoring of the MG operation. Full details on the power monitors features and functions, calibration, and service can be found in the service manual.

12.0 Optional Enclosures: These notes pertain to weather as well as sound attenuating enclosures.

12.1 The enclosure is constructed in aluminum, and is provided with:

12.1.1 Access Door for belts (or couplings) service

12.1.2 Circulating fan

12.1.3 Thermostat switch

12.1.4 Access for circuit breaker, voltage adjustment, power monitoring, and input and output wiring.

12.2 Access for input and output wiring is normally provided through input and output connection boxes to which electrical connections are made by the user. Connections from the motor (or motor starter) to the input box, and from the generator (or output circuit breaker) to the output box are made by Georator.

12.3 The enclosures are either mounted (bolted) on the MG steel base, or are “drop over” type. The latter will be supplied as a separate item and final electrical connection for the fan and thermostat switch is carried out by the user.

TENSIONING GUIDE FOR V-BELT DRIVES

Although belts are tensioned properly before shipment, loosening may occur during the first weeks of operation. Tension should be checked after the first 24 to 40 hours of operation.

Ideal tension is the tension at which the belt will not slip under peak load conditions. However, note that over tensioning shortens belt and bearing life. Avoid the use of belt dressing as this will damage the belts and lead to premature failure.

While an "educated thumb" may be acceptable for ordinary drives, we recommend the use of a tension gauge which measures the pounds force required to deflect the belt a specified distance. Vendors such as TB Woods provided detailed data on upper and lower limits for tension as a function of belt size and length and should be used for precise data.
(see: http://www.tbwoods.com/index.php for their free downloads).

General data is shown below:

Belt Type	Smaller Sheave Dia.	Used Belt, lbs. force	New Belt, lbs force
BX	4.4 – 5.6	7.1	10.5
BX	5.8 – 8.6	7.3	10.9
CX	7.0 – 9.0	14.7	21.8
CX	9.5 – 16.0	15.9	23.5
D	12.0 – 16.0	21.2	31.3
3VX	4.02 – 6.9	5.3	7.9
5VX	4.4 – 6.7	8.8	13.2
5VX	7.1 – 10.9	14.8	22.1
5VX	11.8 – 16.0	17.1	25.5
8V	12.5 – 17.0	26.8	39.9

BASIC TROUBLE SHOOTING FOR BELT COUPLED MOTOR GENERATOR SETS

1. Check output voltage and output frequency.

   A. Output voltage is adjustable using voltage adjusting pot and screw driver voltage adjustment for voltage regulator. If there is no voltage adjustment, it is likely that the voltage regulator has failed.

      To check voltage regulator, remove leads F+ and F- from the voltage regulator and noting polarity, put a 12 V DC battery, battery charger or DC power supply across F+ and F- leads. Then turn the MG on and the output voltage at no load should be high and stable. If so, the voltage regulator is the only thing that doesn't work. Replace the regulator.

      If this is not the case, then a major generator problem exists that will need factory repair.

2. The output frequency should be within plus or minus 1 percent.

   A. If the no load output frequency is above 1%, check the input frequency—where the output frequency will vary proportionally to the input frequency.

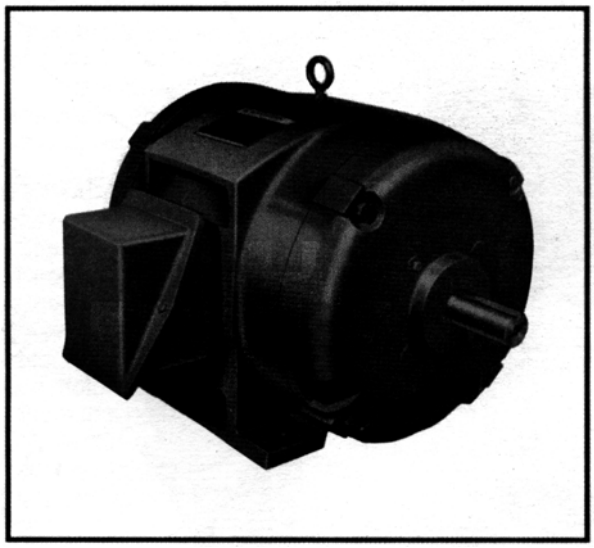
   B. If the loaded output frequency is low (below 1%), check input frequency for proportional relationship. If the input frequency is OK and the input voltage is OK, check for belt tensioning.

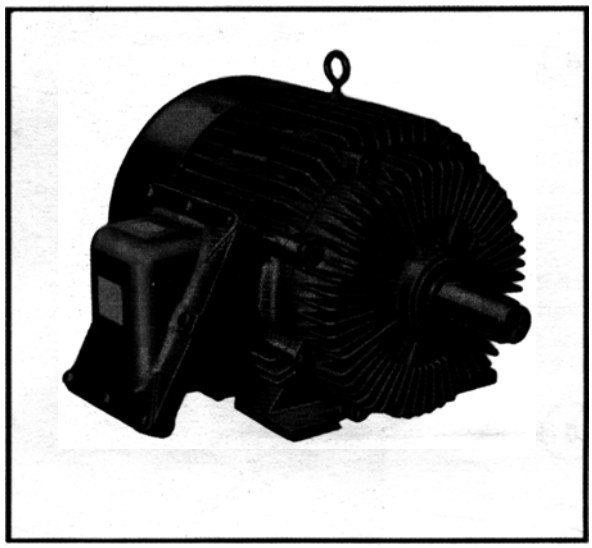
BASIC TROUBLE SHOOTING FOR V-BELTS AND DRIVES

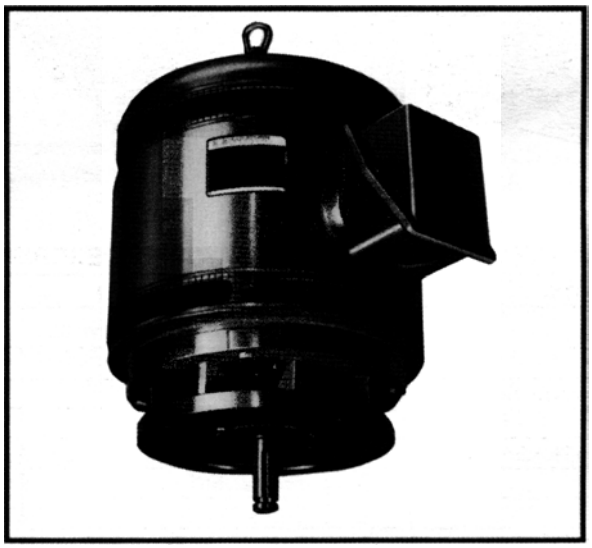
Problem	**Probable Cause**	**Trouble-Shoot**
Short Belt Life	• Spin burns from belt slipping on drive sheave under a stalled load condition or when starting	• Tension belts
	• Gouges or extreme cover wear caused by belts rubbing on drive guards or other objects	• Eliminate obstruction or realign drive to provide clearance
	• High ambient temperature	• Use high-temperature belts • Provide ventilation • Shield belts
	• Grease or oil on belts	• Check for leaky bearings • Clean belts and sheaves
	• Worn sheaves	• Replace sheaves
Belts turn over in grooves	• Damaged cord section in belts • Frayed or gouged belts	• Replace belts
	• Excessive vibration	• Tension belts • Replace belts if damaged
	• Worn sheaves	• Replace sheaves
	• Sheave misalignment	• Realign sheaves
Belts Squeal	• High starting load • Belts not tensioned properly • Excessive overload	• Tension drive • Redesign & replace drive
	• Insufficient arc of contact	• Revise centerline distance
Belt Breakage	• Foreign material in drive	• Provide drive guard (standard on Gerator units)
	• Belts damaged during installation	• Follow installation instructions
	• Shock or extreme overload	• Eliminate overload • Redesign drive
Excess Vibration	• Damaged belt cord section	• Replace belts
	• Loose belts	• Tension drive
	• Belts improperly tensioned	• Tension belts evenly

MARATHON® ELECTRIC

Standard Induction Motors

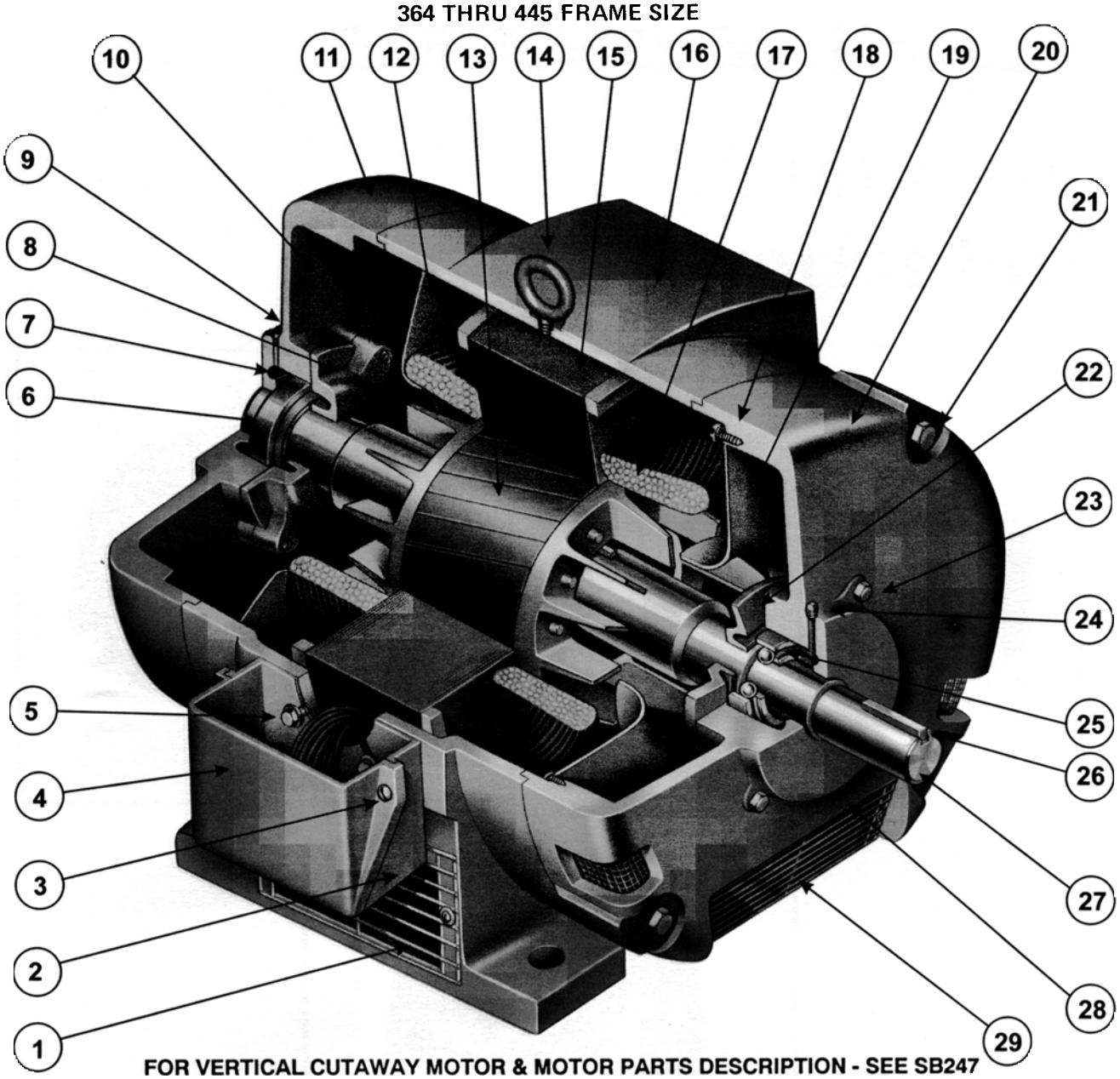






Installation, Operation, & Maintenance Instructions

TYPICAL CUTAWAY VIEW OF A MARATHON DESIGNED, DRIPPROOF, HORIZONTAL INTEGRAL HORSEPOWER MOTOR & PARTS DESCRIPTION 364 THRU 445 FRAME SIZE



FOR VERTICAL CUTAWAY MOTOR & MOTOR PARTS DESCRIPTION - SEE SB247

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1.	** Frame Vent Screen	11.	Bracket O.P.E.	21.	Bracket Holding Bolt
2.	Conduit Box Bottom	12.	Baffle Plate O.P.E.	22.	Inner Bearing Cap P.E.
3.	Conduit Box Top-Holding Screw	13.	Rotor Core	23.	Inner Bearing Cap Bolt
4.	Conduit Box Top	14.	Lifting Eye Bolt	24.	Grease Plug
5.	Conduit Box Bottom-Holding Bolt	15.	Stator Core	25.	*Ball Bearing P.E.
6.	*Ball Bearing O.P.E.	16.	Frame	26.	Shaft Extention Key
7.	Pre-loading Spring	17.	Stator Winding	27.	Shaft
8.	Inner Bearing Cap O.P.E.	18.	Baffel Plate Holding Screw	28.	Drain Plug (grease)
9.	Grease Plug	19.	Baffle Plate P.E.	29.	** Bracket Screen
10.	Inner Bearing Cap Bolt	20.	Bracket P.E.		

P.E. = Pulley End

O.P.E. = Opposite Pulley End

* = Bearing Numbers are shown on motor nameplate when requesting information or parts always give complete motor description, model and serial numbers.

** = Bracket and frame screens are optional.

WARNING

These instructions must be followed to ensure safe and proper installation, operation and maintenance of the motor. They should be brought to the attention of all persons who install, operate or maintain this equipment.

GENERAL INFORMATION

Marathon Electric motors are all fully factory tested and inspected before shipping. Damage during shipment and storage can occur. Motors not correctly matched to the power supply and/or the load will not operate properly. These instructions are intended as a guide to identify and eliminate these problems before they are overlooked or cause further damage.

ACCEPTANCE

Check carefully for any damage that may have occurred in transit. If any damage or shortage is discovered, do not accept until an appropriate notation on the freight bill is made. Any damage discovered after receipt of equipment should be immediately reported to the carrier.

STORAGE

A. Keep motors clean
   1. Store indoors
   2. Keep covered to eliminate airborne dust and dirt.
   3. Cover openings for ventilation, conduit connections, etc. to prevent entry of rodents, snakes, birds, and insects, etc.

B. Keep motors dry
   1. Store in a dry area indoors
   2. Temperature swings should be minimal to prevent condensation.
   3. Space heaters are recommended to prevent condensation.
   4. Treat unpainted flanges, shafts, and fittings with a rust inhibitor.
   5. Check insulation resistance before putting motor into service. (Consult manufacturer for guidelines).

C. Keep Bearings Lubricated
   1. Once per month, rotate shaft several turns to distribute grease in bearings.
   2. If unit has been stored more than one year, add grease before start-up. (Refer to lubrication procedure).

INSTALLATION

UNCRATING AND INSPECTION

After uncrating, check for any damage which may have been incurred in handling. The motor shaft should turn freely by hand. Repair or replace any loose or broken parts before attempting to use the motor.

Check to be sure that motor has not been exposed to dirt, grit, or excessive moisture in shipment or storage before installation.

Measure insulation resistance (see operation). Clean and dry the windings as required.

Never start a motor which has been wet without having it thoroughly dried.

SAFETY

Motors should be installed, protected and fused in accordance with latest issue of National Electrical Code, NEMA Standard Publication No. MG 2 and local codes.

Eyebolts or lifting lugs are intended for lifting the motor only. These lifting provisions should never be used when lifting or handling the motor with other equipment (i.e. pumps, gear boxes, fans or other driven equipment) as a single unit. Be sure the eyebolt is fully threaded and tight in its mounting hole.

Eyebolt lifting capacity ratings is based on a lifting alignment coincident with the eyebolt centerline. Eyebolt capacity reduces as deviation from this alignment increases. See NEMA MG 2.

Frames and accessories of motors should be grounded in accordance with National Electrical Code (NEC) Article 430. For general information of grounding refer to NEC Article 250.

Rotating parts such as pulleys, couplings, external fans, and shaft extensions should be permanently guarded.

LOCATION

In selecting a location for the motor, consideration should be given to environment and ventilation. A motor with the proper enclosure for the expected operating condition should be selected.

The ambient temperature of the air surrounding the motor should not exceed 40°C (104°F) unless the motor has been especially designed for high ambient temperature applications. The free flow of air around the motor should not be obstructed.

The motor should never be placed in a room with a hazardous process, or where flammable gases or combustible material may be present, unless it it specifically designed for this type of service.

1. Dripproof (open) motors are intended for use indoors where atmosphere is relatively clean, dry and non-corrosive.
2. Dripproof (open) fire pump motors are to be installed in a Type 2 dripproof environment as defined in NEMA 250.
3. Totally enclosed motors may be installed where dirt, moisture and corrosion are present, or in outdoor locations.
4. Explosion proof motors are built for use in hazardous locations as indicated by Underwriters' label on motor. Consult UL, NEC, and local codes for guidance.

Refer to Marathon Electric for application assistance.

FLOOR MOUNTING

Motors should be provided with a firm, rigid foundation, with the plane of four mounting pads flat within .010" for 56 to 210 frame; .015" from 250 through 500 frame. This may be accomplished by shims under the motor feet. For special isolation mounting, contact Marathon Electric for assistance.

V-BELT DRIVE

1. Select proper type and number of belts and sheaves. Excessive belt load will damage bearings. Sheaves should be in accordance to NEMA Spec. MG-1 or as approved by the manufacturer for a specific application.
2. Align sheaves carefully to avoid axial thrust on motor bearing. The drive sheave on the motor should be positioned toward the motor so it is as close as possible to the bearing.

3. When adjusting belt tension, make sure the motor is secured by all mounting bolts before tightening belts.
4. Adjust belt tension to belt manufacturers recommendations. Excessive tension will decrease bearing life.
5. For more information see Marathon Electric Publication SB588.

DIRECT CONNECTED DRIVE

Flexible or solid shaft couplings must be properly aligned for satisfactory operation. On flexible couplings, the clearance between the ends of the shafts should be in accordance with the coupling manufacturer's recommendations or NEMA standards for end play and limited travel in coupling.

MISALIGNMENT and RUN-OUT between direct connected shafts will cause increased bearing loads and vibration even when the connection is made by means of a flexible coupling. Excessive misalignment will decrease bearing life. Proper alignment, per the specifications of the coupling being used, is critical.

Some large motors are furnished with roller bearings. Roller bearings should **not** be used for direct drive.

ELECTRICAL CONNECTIONS

CAUTION

Install and ground per local and national codes. Consult qualified personnel with questions or if repairs are required.

WARNING

1. Disconnect power before working on motor or driven equipment.
2. Motors with automatic thermal protectors will automatically restart when the protector temperature drops sufficiently. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.
3. Motors with manual thermal protectors may start unexpectedly after protector trips. If manual protector trips, disconnect motor from power line. After protector cools (five minutes or more) it can be reset and power may be applied to motor.
4. Discharge all capacitors before servicing motor.
5. Always keep hands and clothing away from moving parts.
6. Never attempt to measure the temperature rise of a motor by touch. Temperature rise must be measured by thermometer, resistance, imbedded detector, or thermocouple.
7. Electrical repairs should be performed by trained and qualified personnel only.
8. Failure to follow instructions and safe electrical procedures could result in serious injury or death.
9. If safety guards are required, be sure the guards are in use.

1. All wiring, fusing, and grounding must comply with National Electrical Codes and local codes.
2. To determine proper wiring, rotation and voltage connections, refer to the information and diagram on the nameplate, separate connection plate or decal. If the plate or decal has been removed, contact Marathon Electric for assistance.
3. Use the proper size of line current protection and motor controls as required by the National Electrical Code and local codes. Recommended use is 125% of full load amps as shown on the nameplate for motors with 40°C ambient and a service factor over 1.0. Recommended use is 115% of full load amps as shown on the nameplate for all other motors. Do not use protection with larger capacities than recommended. Three phase motors must have all three phases protected.

THERMAL PROTECTOR INFORMATION

The nameplate will indicate one of the following:

1. Motor is thermally protected
2. Motor is not thermally protected
3. Motor is provided with overheat protective device

For examples, refer to paragraphs below:

1. Motors equipped with built-in thermal protection have "THERMALLY PROTECTED" stamped on the nameplate. Thermal protectors open the motor circuit electrically when the motor overheats or is overloaded.
   The protector cannot be reset until the motor cools. If the protector is automatic, it will reset itself. If the protector is manual, press the red button to reset.
2. Motors without thermal protection have nothing stamped on nameplate about thermal protection.
3. Motors that are provided with overheat protective device that does not open the motor circuit directly will indicate "WITH OVERHEAT PROTECTIVE DEVICE".
   A. Motors with this type of "Overheat Protective Device" have protector leads brought out in the motor conduit box marked "P1" and "P2". These leads are intended for connection in series with the stop button of the 3-wire pilot circuit for the magnetic starter which controls the motor. See Figure 1.
   B. The circuit controlled by the above "Overheat Protective Device" must be limited to a maximum of 600 volts and 360 volt-amps.

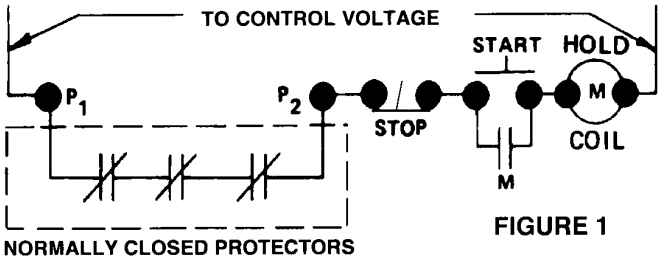
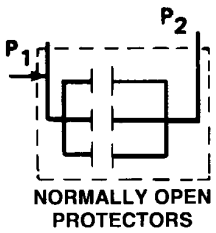


FIGURE 1



Normally Open (N/O) Motor Thermostats may be used in conjunction with controls installed by Original Equipment Manufacturers.

FIGURE 1A

CHANGING ROTATION

1. Keep hands and clothing away from rotating parts.
2. Before the motor is coupled to the load, determine proper rotation.
3. Check rotation by jogging or bumping. Apply power to the motor leads for a short period of time, enough to just get motor shaft to rotate a slight amount to observe shaft rotating direction.
4. Three phase - interchange any two (2) of the three (3) line leads. Single phase - reconnect per the connection diagram on the motor.

REDUCED VOLTAGE STARTING

Motors used on reduced voltage starting, should be carefully selected based upon power supply limitations and driven load requirements. The motors starting torque will be reduced when using reduced voltage starting. The elapsed time on the start step should be kept as short as possible and should not exceed 5 seconds. It is recommended that this time be limited to 2 seconds. Refer to Marathon Electric for application assistance.

OPERATION

WARNING

Disconnect and lock out before working on motor or driven equipment.

BEFORE INITIAL STARTING

1. If a motor has become damp in shipment or in storage, measure the insulation resistance of the stator winding.

$$\text{Minimum Insulation Resistance In Megohms} = 1 + \frac{\text{Rated Voltage}}{1000}$$

Do not attempt to run the motor if the insulation resistance is below this value.

2. If insulation resistance is low, dry out the moisture in one of the following ways:
   a. Bake in oven at temperature not more than 90°C (194°F).
   b. Enclose motor with canvas or similar covering, leaving a hole at the top for moisture to escape, and insert heating units or lamps.
   c. Pass a current at low voltage (rotor locked) through the stator winding. Increase the current gradually until the winding temperature, measured with a thermometer, reaches 90°C (194°F). Do not exceed this temperature.
3. See that voltage and frequency stamped on motor and control nameplates correspond with that of the power line.
4. Check all connections to the motor and control with the wiring diagram.
5. Be sure rotor turns freely when disconnected from the load. Any foreign matter in the air gap should be removed.
6. Leave the motor disconnected from the load for the initial start (see following caution). Check for proper rotation. Check for correct voltage (within ± 10% of nameplate value) and that it is balanced within 1% at the motor terminals. After the machine is coupled to the load, check that the nameplate amps are not exceeded. Recheck the voltage level and balance under load per the above guidelines.

   Shut down the motor if the above parameters are not met or if any other noise or vibration disturbances are present. Consult NEMA guidelines or the equipment manufacturer if any questions exist before operating equipment.

CAUTION

For motors nameplated as "belted duty only", do not run motor without belts properly installed.

COLLECTOR RINGS (Wound Rotor Motors Only)

The collector rings are sometimes treated at the factory to protect them while in stock and during shipment. The brushes have been fastened in a raised position. Before putting the motor into service, the collector rings should be cleaned to remove this treatment. Use a cleaning fluid that is made for degreasing electrical equipment. All of the brushes must be released and lowered to the collector surface. Keep the rings clean and maintain their polished surfaces. Ordinarily, the rings will require only occasional wiping with a piece of canvas or non-linting cloth. Do not let dust or dirt accumulate between the collector rings.

BRUSHES (Wound Rotor Motors Only)

See that the brushes move freely in the holders and at the same time make firm, even contact with the collector rings. The pressure should be between 2 and 3 pounds per square inch of brush surface.

When installing new brushes, fit them carefully to the collector rings. Be sure that the copper pigtail conductors are securely fastened to, and make good contact with, the brushholders.

ALLOWABLE VOLTAGE AND FREQUENCY RANGE

If voltage and frequency are within the following range, motors will operate, but with somewhat different characteristics than obtained with correct nameplate values.

1. Voltage: Within 10% above or below the value stamped on the nameplate. On three phase systems the voltage should be balanced within 1%. A small voltage unbalance will cause a significant current unbalance.
2. Frequency: Within 5% above or below the value stamped on the nameplate.
3. Voltage and Frequency together: Within 10% (providing frequency above is less than 5%) above or below values stamped on the nameplate.

CLEANLINESS

Keep both the interior and exterior of the motor free from dirt, water, oil and grease. Motors operating in dirty places should be periodically disassembled and thoroughly cleaned.

CONDENSATION DRAIN PLUGS

All explosion proof and some totally enclosed motors are equipped with automatic drain plugs, they should be free of oil, grease, paint, grit and dirt so they don't clog up. The drain system is designed for normal floor (feet down) mounting. For other mounting positions, modification of the drain system may be required, consult Marathon Electric.

SERVICE

WARNING

Disconnect power before working on motor or driven equipment. Motors with automatic thermal protectors will automatically restart when the protector cools. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.

CAUTION

Overgreasing bearings can cause premature bearing and/or motor failure. The amount of grease added should be carefully controlled.

NOTE

If lubrication instructions are shown on the motor nameplate, they will supersede this general instruction.

Marathon Electric motors are pregreased with a polyurea mineral oil NGLI grade 2 type grease unless stated otherwise on the motor nameplate. Some compatible brands of polyurea mineral base type grease are: Chevron SRI #2, Rykon Premium #2, Exxon Polyrex EM or Texaco Polystar RB.

Motors are properly lubricated at the time of manufacture. It is not necessary to lubricate at the time of installation unless the motor has been in storage for a period of 12 months or longer (refer to lubrication procedure that follows).

LUBRICATION PROCEDURES

1. Stop motor. Disconnect and lock out of service.
2. Remove contaminants from grease inlet area.
3. Remove filler and drain plugs.
4. Check filler and drain holes for blockage and clean as necessary.
5. Add proper type and amount of grease. See the Relubrication Time Intervals table for service schedule and Relubrication Amounts table for volume of grease required.
6. Wipe off excess grease and replace filler and drain plugs (see following warning).
7. Motor is ready for operation.

WARNING

If motor is nameplated for hazardous locations, do not run motor without all of the grease or drain plugs installed.

RELUBRICATION TIME INTERVAL

(For motors with regreasing provisions).

Service Condition	NEMA FRAME SIZE					
	140-180		210-360		400-510	
	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM
Standard	3 yrs.	6 months	2 yrs.	6 months	1 yr.	3 months
Severe	1 yr.	3 months	1 yr.	3 months	6 months	1 month
Seasonal	See Note 2.					

NOTE

1. For motors nameplated as "belted duty only" divide the above intervals by 3.
2. Lubricate at the beginning of the season. Then follow service schedule above.

SEASONAL SERVICE: The motor remains idle for a period of 6 months or more.

STANDARD SERVICE: Up to 16 hours of operation per day, indoors, 100°F maximum ambient.

SEVERE SERVICE: Greater than 16 hours of operation per day. Continuous operation under high ambient temperatures (100° to 150°F) and/or any of the following: dirty, moist locations, high vibration (above NEMA standards), heavy shock loading, or where shaft extension end is hot.

RELUBRICATION AMOUNTS

(For motors with regreasing provisions).

NEMA FRAME SIZE	VOLUME cu. in. (fluid oz.)
140	.25 (.14)
180	.50 (.28)
210	.75 (.42)
250	1.00 (.55)
280	1.25 (.69)
320	1.50 (.83)
360	1.75 (.97)
400	2.25 (1.2)
440	2.75 (1.5)
500	3.00 (1.7)

TROUBLESHOOTING

WARNING

1. Disconnect power before working on motor or driven equipment.
2. Motors with automatic thermal protectors will automatically restart when the protector temperature drops sufficiently. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.
3. Motors with manual thermal protectors may start unexpectedly after protector trips. If manual protector trips, disconnect motor from power line. After protector cools (five minutes or more) it can be reset and power may be applied to motor.
4. Discharge all capacitors before servicing motor.
5. Always keep hands and clothing away from moving parts.
6. Never attempt to measure the temperature rise of a motor by touch. Temperature rise must be measured by thermometer, resistance, imbedded detector, or thermocouple.
7. Electrical repairs should be performed by trained and qualified personnel only.
8. Failure to follow instructions and safe electrical procedures could result in serious injury or death.
9. If safety guards are required, be sure the guards are in use.

If trouble is experienced in the operation of the motor, make sure that:

1. The bearings are in good condition and operating properly.
2. There is no mechanical obstruction to prevent rotation in the motor or in the driven load.
3. The air gap is uniform. (Consult manufacturer for specifications).
4. All bolts and nuts are tightened securely.
5. Proper connection to drive machine or load has been made.

In checking for electrical troubles, be sure that:

1. The line voltage and frequency correspond to the voltage and frequency stamped on the nameplate of the motor.
2. The voltage is actually available at motor terminals.
3. The fuses and other protective devices are in proper condition.
4. All connections and contacts are properly made in the circuits between the control apparatus and motor.

These instructions do not cover all details or variations in equipment nor provide for every possible condition to be met in connection with installation, operation or maintenance. Should additional information be desired for the purchaser's purposes, the matter should be referred to the nearest Marathon Electric Manufacturing Corp. sales office listed on the back page.

MOTOR TROUBLE SHOOTING CHART

Your motor service and any trouble shooting must be handled by qualified persons who have proper tools and equipment.

TROUBLE	CAUSE	WHAT TO DO
Motor fails to start	Blown fuses	Replace fuses with proper type and rating
	Overload trips	Check and reset overload in starter.
	Improper power supply	Check to see that power supplied agrees with motor nameplate and load factor.
	Improper line connections	Check connections with diagram supplied with motor.
	Open circuit in winding or control switch	Indicated by humming sound when switch is closed. Check for loose wiring connections. Also see that all control contacts are closing.
	Mechanical failure	Check to see if motor and drive turn freely. Check bearings and lubrication.
	Short circuited stator	Indicated by blown fuses. Motor must be rewound.
	Poor stator coil connection	Remove end bells, locate with test lamp.
	Rotor defective	Look for broken bars or end rings.
	Motor may be overloaded	Reduce load.
Motor stalls	One phase may be open	Check lines for open phase.
	Wrong application	Change type or size. Consult manufacturer.
	Overload	Reduce load.
	Low voltage	See that nameplate voltage is maintained. Check connection.
	Open circuit	Fuses blown, check overload relay, stator and pushbuttons.
Motor runs and then dies down	Power failure	Check for loose connections to line, to fuses and to control.
Motor does not come up to speed	Not applied properly	Consult supplier for proper type.
	Voltage too low at motor terminals because of line drop.	Use higher voltage on transformer terminals or reduce load. Check connections. Check conductors for proper size.
	Starting load too high	Check load motor is supposed to carry at start.
	Broken rotor bars or loose rotor	Look for cracks near the rings. A new rotor may be required as repairs are usually temporary.
	Open primary circuit	Locate fault with testing device and repair.
Motor takes too long to accelerate and/or draws high amp	Excessive load	Reduce load.
	Low voltage during start	Check for high resistance. Adequate wire size.
	Defective squirrel cage rotor	Replace with new rotor.
	Applied voltage too low	Get power company to increase power tap.
Wrong rotation	Wrong sequence of phases	Reverse connections at motor or at switchboard.
Motor overheats while running under load	Overload	Reduce load.
	Frame or bracket vents may be clogged with dirt and prevent proper ventialation of motor.	Open vent holes and check for a continuous stream of air from the motor.
	Motor may have one phase open	Check to make sure that all leads are well connected.
	Grounded coil	Locate and repair.
	Unbalanced terminal voltage	Check for faulty leads, connections and transformers.
Motor vibrates	Motor misaligned	Realign.
	Weak support	Strengthen base
	Coupling out of balance	Balance coupling.
	Driven equipment unbalanced	Rebalance driven equipment.
	Defective bearings	Replace bearing.
	Bearings not in line	Line up properly.
	Balancing weights shifted	Rebalance motor.
	Polyphase motor running single phase	Check for open circuit.
	Excessive end play	Adjust bearing or add shim.
Unbalanced line current on polyphase motors during normal operation	Unequal terminal volts	Check leads and connections.
	Single phase operation	Check for open contacts.
	Unbalanced voltage	Correct unbalanced power supply.
Scraping noise	Fan rubbing air shield	Remove interference.
	Fan striking insulation	Clear fan.
	Loose on bedplate	Tighten holding bolts.
Noisy operation	Airgap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
Hot bearings general	Bent or sprung shaft	Straighten or replace shaft.
	Excessive belt pull	Decrease belt tension.
	Pulleys too far away	Move pulley closer to motor bearing.
	Pulley diameter too small.	Use larger pulleys.
	Misalignment	Correct by realignment of drive.
Hot bearings ball	Insufficient grease	Maintain proper quantity of grease in bearing.
	Deterioration of grease or lubircant contaminated	Remove old grease, wash bearings thoroughly in kerosene and replace with new grease.
	Excess lubricant	Reduce quantity of grease, bearing should not be more than 1/2 filled.
	Overloaded bearing	Check alignment, side and end thrust.
	Broken ball or rough races	Replace bearing, first clean housing thoroughly.

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MAGNAPLUS® GENERATOR

280–430 Frame
Installation, Operation, and Maintenance Manual

MARATHON ELECTRIC®
A Subsidiary of Regal-Beloit Corporation

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SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures contained herein, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your MagnaPLUS generator. Each section of this manual has caution and warning messages. These messages are for your safety, and the safety of the equipment involved. If any of these cautions or warnings are not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and lock out all controls to prevent an unexpected start-up of the generator set driver. Proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving your MagnaPLUS generator are pointed out in the installation and maintenance sections. Incorrect lifting or moving can result in personal injury or damage to the unit.

Prior to start-up of the unit ensure that all generator leads are properly connected to the generator link board located inside the connection box. Always assume that there will be voltage present at the generator terminals whenever the generator's shaft is rotating**,** and proceed accordingly. Residual voltage is present at the generator terminals and at the automatic voltage regulator panel connections even with the regulator fuse removed. Caution must be exercised, or serious injury or death can result.

This manual is not intended to be a substitute for properly trained personnel. Installation and repairs should only be attempted by qualified, trained people. The cautions and warnings point out known conditions and situations that are potentially hazardous. Each installation may well create its own set of hazards

When in doubt, ask. Questions are much easier to handle than mistakes caused by a misunderstanding of the information presented in this manual.

RECEIVING AND STORAGE

RECEIVING AND STORAGE

Upon receipt of the generator, it is recommended that it be carefully examined for possible shipping damage. The generator was given to the freight carrier in good condition; thus, the carrier is responsible for the product from the factory dock to the destination. Any damage should be noted on the freight bill before accepting the shipment. Any claims for damage must be promptly filed with the delivering carrier.

UNPACKING AND HANDLING

Carefully read all instruction tags shipped with the unit. When lifting, attach an overhead crane to the lifting lug(s) on the generator frame. Apply lifting forces in a vertical direction. When transporting single bearing generators, the generator's rotor must be adequately supported to prevent damage.

WARNING

THE LIFTING LUG(S) ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT A COMPLETE GENERATOR AND DRIVER ASSEMBLY BY MEANS OF LIFTING LUG(S) ON THE GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

STORAGE

In the event that the generator is not immediately installed on its prime mover, it is recommended that the unit be stored indoors in a clean, dry area which is not subject to rapid changes in temperature and humidity. If the generator is stored for a long period of time, the generator should be tested, cleaned and dried as required before being put into service. See the maintenance section of this manual for further information. If the unit has been stored in an area where it has been subject to vibration, it is recommended that the bearing(s) be inspected and replaced as necessary.

PRINCIPLES OF OPERATION

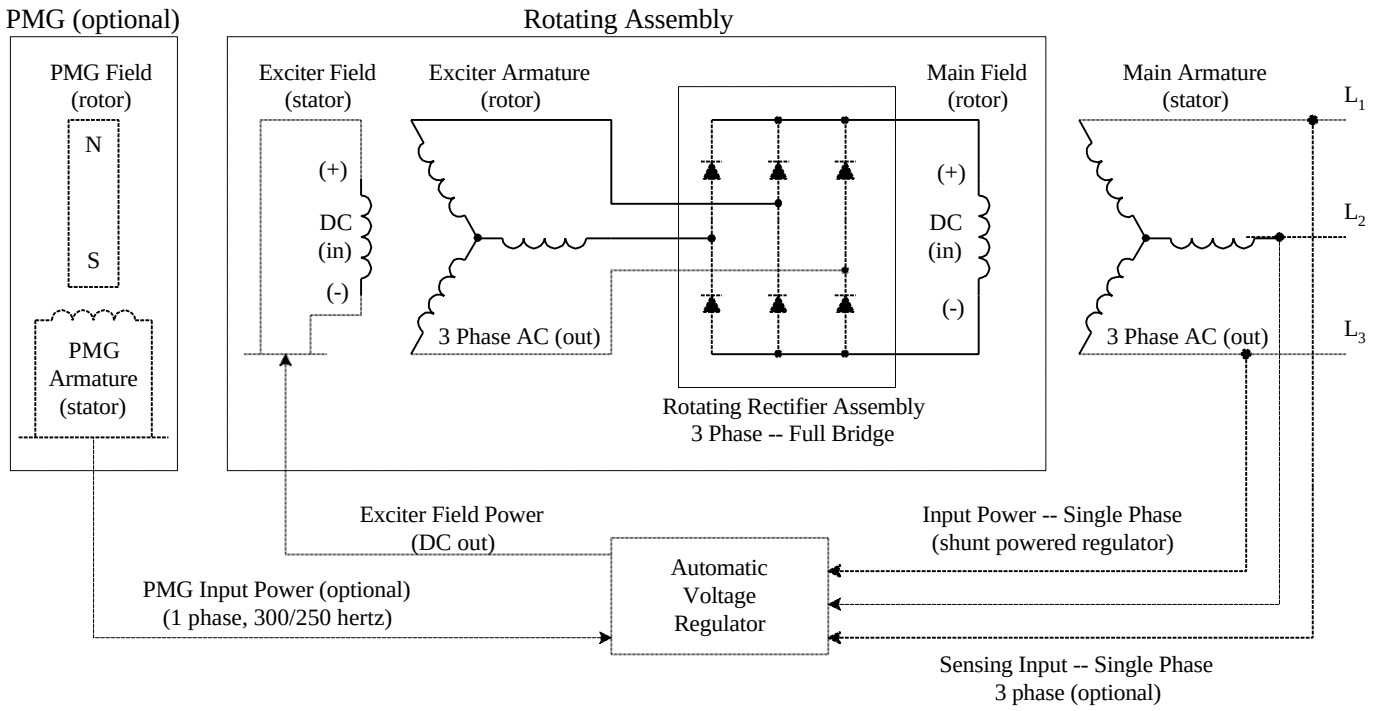

FIGURE 1 -- MagnaPLUS Circuit Diagram

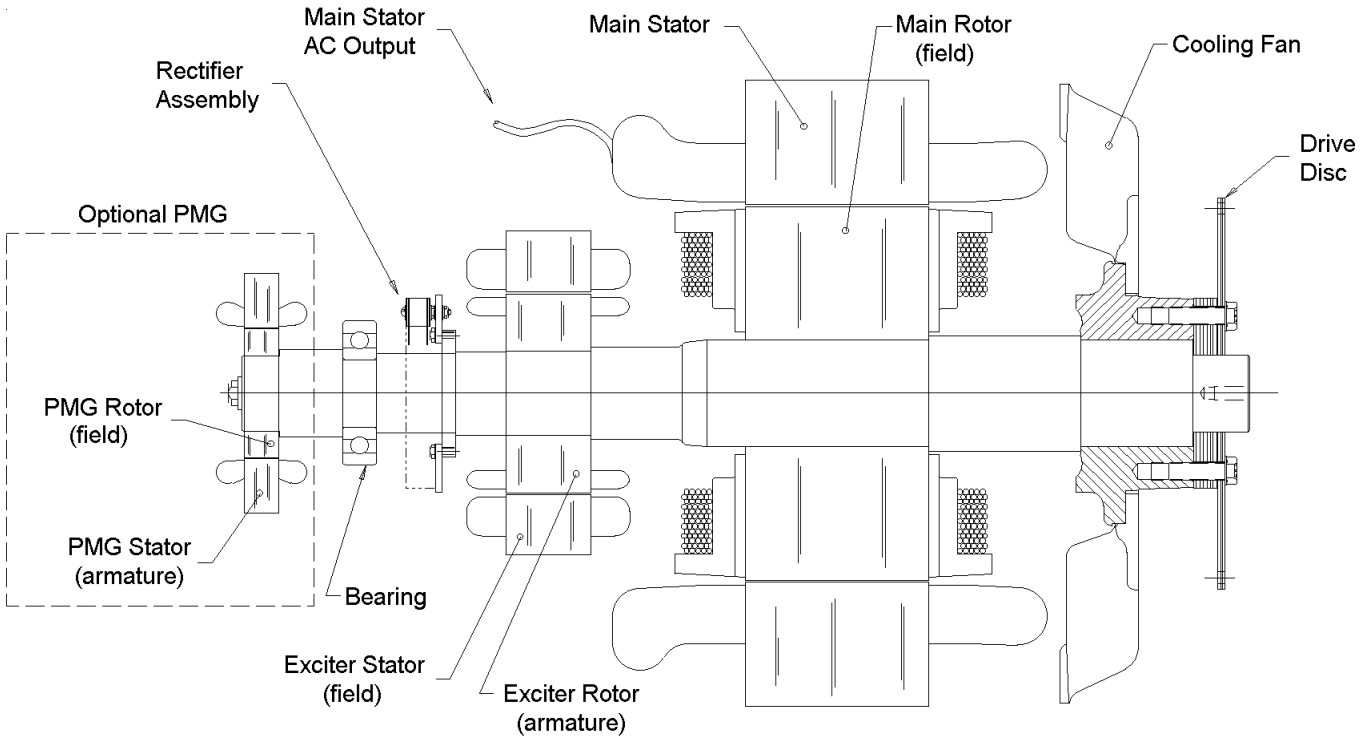

FIGURE 2 -- Typical MagnaPLUS Layout Diagram

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PRINCIPLE OF OPERATION

MagnaPLUS generators are a brushless, self excited, externally voltage regulated, synchronous AC generator. The generator is made up of six major components: main stator (armature), main rotor (field), exciter stator (field), exciter rotor (armature), rectifier assembly, and voltage regulator. In understanding the above terminology, note the following: stators are stationary, rotors rotate, a field is an electrical input, and an armature is an electrical output. These system components are electrically interconnected as shown in figure 1 and physically located as shown in figure 2.

The generator's exciter consists of a stationary field and a rotating armature. The stationary field (exciter stator) is designed to be the primary source of the generator's residual magnetism. This residual magnetism allows the exciter rotor (armature) to produce AC voltage even when the exciter stator (field) is not powered. This AC voltage is rectified to DC by the rotating rectifier assembly and fed directly to the main rotor (field). As the generator shaft continues to rotate, the main rotor (field) induces a voltage into the generator's main stator (armature). At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator. After the generator has established the initial residual voltage, the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

Voltage Regulation

In the standard configuration (shunt excited), the automatic voltage regulator receives both its input power and voltage sensing from the generator's output terminals (See Figure 1). With the optional PMG configuration, the regulator receives input power from the PMG. The regulator automatically monitors the generator's output voltage against an internal reference set point and provides the necessary DC output voltage to the exciter field required to maintain constant generator terminal voltage. The generator's terminal voltage is changed by adjusting the regulator's reference set point. Consult the regulator manual for specific adjustment and operating instructions.

MOTOR STARTING

When a motor is started, a large surge of current is drawn by the motor. This starting current is equivalent to the motors locked rotor or stall current and is 5 to 10 times normal full load current. When the generator supplies this in-rush of starting current, the generator voltage dips temporarily. If the motor is too large for the generator, the generator's voltage dips greater than 30 percent. This may result in the motor starter de-energizing or the motor stalling. MagnaPlus generators generally supply .3 to .4 horsepower per generator KW in motor starting capability. For specific data contact Marathon Electric.

PARALLEL OPERATION

All MagnaPlus generators are built with 2/3 pitch main stator windings and full amortisseur (damper) windings. These features make the MagnaPlus generators suitable for parallel operation when equipped with the proper voltage regulators and voltage regulator accessories. Consult with the factory for further information relative to parallel operations.

NONLINEAR LOADING

Solid state electronic control devices (variable frequency drives, precision motor controls, battery chargers, etc.) utilize electronic switching circuits (thyristors, SCRs, Diodes, etc.). These switching circuits introduce high frequency harmonics which distort the normal wave form of the generator. This creates additional heat in the generator windings and may cause the generator to over-heat. Problems which can occur are not limited to the generator. Poor wave shape may adversely effect various loads connected to the generator. Consult Marathon Electric for further information relative to nonlinear loads.

INSTALLATION

PREPARATION FOR USE

Although the generator has been carefully inspected and tested in operation prior to shipment from the factory, it is recommended that the generator be thoroughly inspected. Check all bolts for tightness and examine the insulation on lead wires for chafing prior to proceeding with installation. Remove all shipping tapes, bags, skids and rotor support blocking. For two bearing units, rotate the shaft by hand to ensure that it rotates smoothly without binding.

WARNING

DISABLE AND LOCKOUT ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THE GENERATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START, DISCONNECT THE AIR SUPPLY. FOR MOTOR GENERATOR SETS, OPEN THE POWER SUPPLY TO THE DRIVE MOTOR. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE.

NEVER "BAR OVER" THE ENGINE GENERATOR SET USING THE GENERATOR'S FAN. THE FAN IS NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN COULD DAMAGE THE FAN AND RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

GENERATOR MOUNTING

Single Bearing Units.

Single bearing units are provided with an SAE flywheel housing adapter flange and flexible drive discs. Coupling the generator's shaft to the engine flywheel is accomplished with special steel drive discs bolted to the shaft. In addition to the drive discs, there may be a hub spacer, spacer discs, or a combination of hub spacer and spacer discs inserted between the drive discs and the shaft to achieve the proper shaft extension ("G" dimension per SAE J620c). Holes are provided in the periphery of the coupling discs which correspond to tapped holes in the prime mover's flywheel. The outside diameter of the drive discs fit in a rabbet in the flywheel so that concentricity is assured.

Grade 8 place bolts and hardened washers are recommended to mount the drive discs to the flywheel. DO NOT USE SPLIT TYPE LOCK WASHERS**.** Split lock washers when biting into the drive disc cause stress risers which may result in the disc fracturing.

The SAE flywheel housing adapter ring and the engine flywheel housing are designed to match each other with no further alignment necessary. Use grade 5 or greater mounting bolts. MagnaPLUS generator frames are constructed with two or three bolt holes per foot. The feet should be shimmed where necessary to obtain solid contact with the sub-base. With the frame securely bolted to the engine flywheel housing, there is no side thrust or pull on the generator frame, thus no real need to secure the feet with more than one bolt per foot.

GENERATOR MOUNTING

Two Bearing Generators -- Direct Drive

Two bearing generators are provided with a keyed shaft extension. For direct drive generators, the assembler furnishes a flexible coupling which is installed between the driver and the generator's shaft. Aligning the generator and its driver as accurately as possible will reduce vibration, increase bearing life, and ensure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Secure the feet of the generator with grade 5 or greater bolts through the holes provided in the mounting feet. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

GENERATOR MOUNTING

Two Bearing Units -- Belt Driven

Two bearing MagnaPLUS generators can be belt driven provided belts are sized and applied correctly. Please refer to your supplier of belts and sheaves for correct sizing and tensioning specifications. A bearing life calculation should be performed. Marathon Electric recommends a minimum B-10 life of 40,000 hours. If cog type belts are used, a vibration may be introduced which could lead to premature failure of the bearings.

END PLAY TESTING

Refer to the engine manual for recommended end play specifications and measurement procedures. If end play is not to specification, it is an indication that the generator shaft is not moving freely in the assembly, and normal life of the thrust bearing could be impaired. Probable causes of this problem are:

1. Improper seating of drive discs in the flywheel resulting in misalignment.

2. Improper mating of generator frame to engine flywheel housing resulting in misalignment.

3. Improper "G" dimension per SAE J620c on either the engine or generator.

TORSIONAL VIBRATION

Torsional vibrations are generated in all rotating shaft systems. In some cases, the amplitude of these vibrations at critical speeds may cause damage to either the generator, its driver, or both. It is therefore necessary to examine the torsional vibration effect on the entire rotating system. IT IS THE RESPONSIBILITY OF THE GENERATOR SET ASSEMBLER TO ASSURE THE TORSIONAL COMPATIBILITY OF THE GENERATOR AND ITS DRIVER. Drawings showing pertinent dimensions and weights of the rotating assembly will be supplied by Marathon Electric upon request.

ENVIRONMENTAL CONSIDERATIONS

The MagnaPLUS generator is designed for heavy duty industrial applications; however, dirt, moisture, heat and vibration are enemies of rotating electrical machinery. Excessive exposure to the elements may shorten generator life. The temperature of the cooling air entering the intake openings of the generator should not exceed the ambient temperature shown on the generator's nameplate. Generators intended for outdoor application should be protected with housings having adequate ventilation. Although the standard insulation systems are moisture and humidity resistant, space heaters are recommended for extreme conditions. If the generator is to be installed in an area where blowing sand and dust are present, the enclosure should be fitted with filters. Filters reduce erosion on the generator's insulation by blocking high velocity abrasive particles generated by the flow of cooling air through the generator. Consult the factory for appropriate filters and generator deratings required.

WIRING CONNECTIONS

Wiring of the generator and accessories should be done in accordance with good electrical practices. Follow government, industry and association standards.

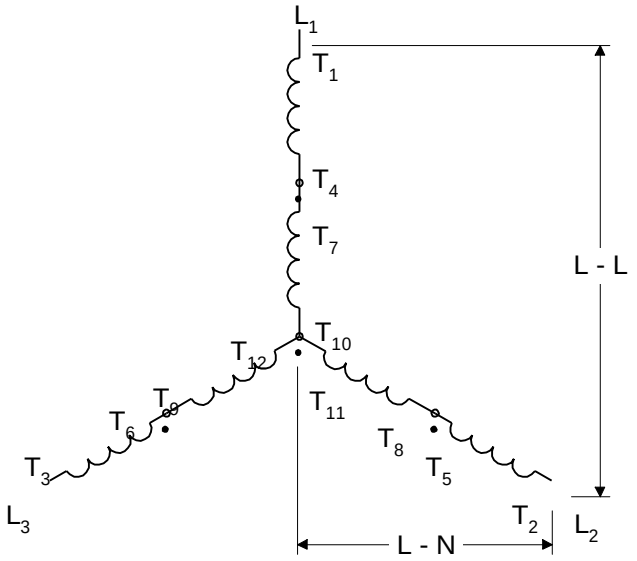
The generator conduit box construction allows cable entry from multiple sides. A hole saw or other appropriate tool may be used to provide for conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit. To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator conduit box.

All MagnaPLUS generators are equipped with link boards (terminal strips) for both internal and external connections. All connections made to the studs of the link board should be made with high quality ring terminals. Ring terminal sizes are: 6 mm (280 Series Frames) and 10 mm (360 and 430 Series Frames). Torque link board connections to the following specifications: 280 frame -- 5.4 NM (4 Ft Lb); 360 & 430 frame -- 27 NM (20 Ft Lb).

Refer to the connection diagram supplied with the generator and / or the proper diagrams shown in this manual. Install all inter-component and external wiring in accordance with national and local electrical codes. The neutral in the following connection diagrams shown below may be either grounded (earthed) or left above ground potential (floating). See national and local codes and / or the system distribution wiring schematic diagram for the proper connection of the neutral.

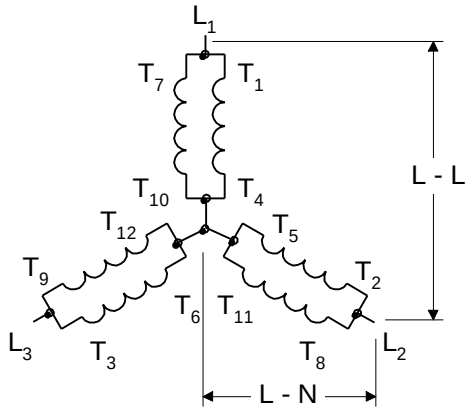
The following connection diagrams are shown for twelve lead generators. Ten lead generators have the same terminal designations except for leads T10, T11, and T12. These three leads are internally connected inside the generator and brought out as a single lead (T0). Ten lead generators can only be connected in a wye configuration

HIGH (SERIES) WYE CONNECTION



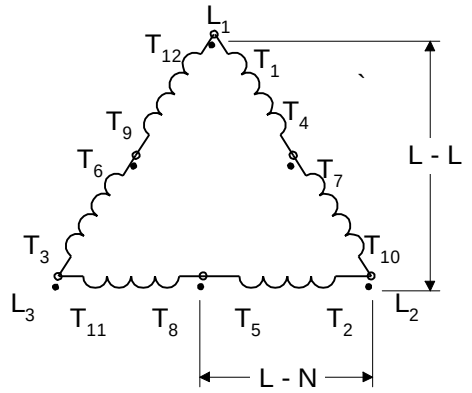
VOLTAGE (HIGH WYE)		
Hz	L-L	L-N
60	480	277
	460	266
	440	254
	416	240
	380	219
50	416	240
	400	231
	380	219

LOW (PARALLEL) WYE CONNECTION



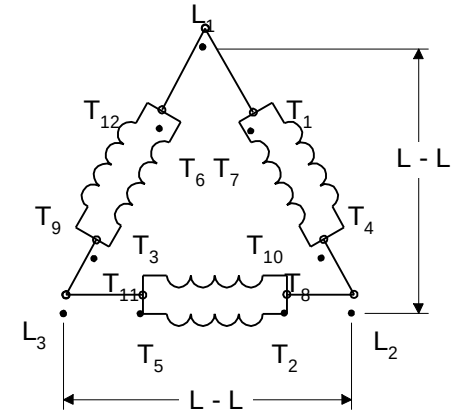
VOLTAGE (LOW WYE)		
Hz	**L-L**	**L-N**
60	240	139
	230	133
	220	127
	208	120
	190	110
50	208	120
	200	115
	190	110

HIGH (SERIES) DELTA CONNECTION



VOLTAGE (HIGH DELTA)		
Hz	**L-L**	**L-N**
60	277	139
	240	120
50	240	120
	220	110
	200	100

LOW (PARALLEL) DELTA CONNECTION



VOLTAGE (LOW DELTA)		
Hz	**L-L**	**L-N**
60	120	NA
	110	NA
50	110	NA
	100	NA

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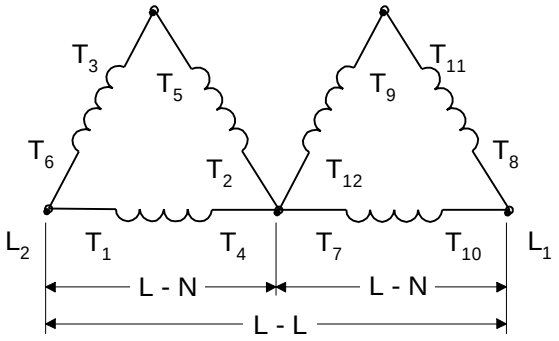
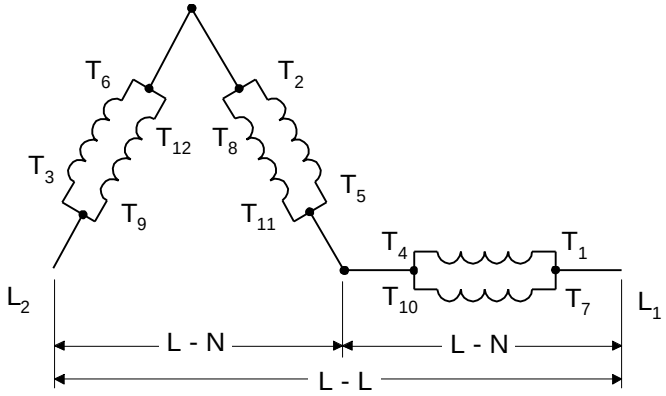
DOUBLE DELTA -- SINGLE PHASE CONNECTION



VOLTAGE (DOUBLE DELTA)		
Hz	**L-L**	**L-N**
60	240	120
	220	110
50	220	110

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

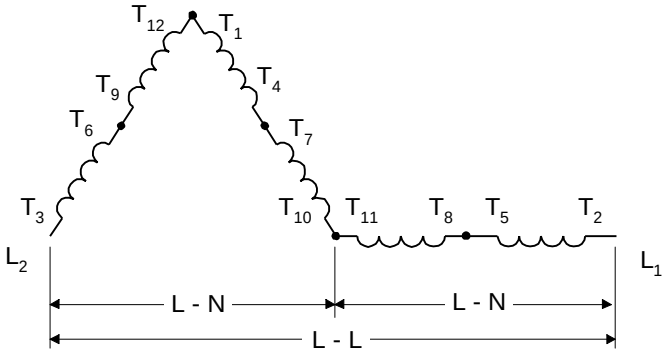
LOW ZIG ZAG -- SINGLE PHASE (PARALLEL) CONNECTION



VOLTAGE (LOW ZIGZAG)		
Hz	**L-L**	**L-N**
60	240	120
	220	110
50	220	110
	200	100

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

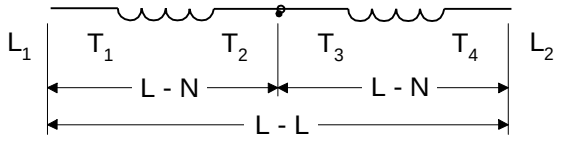
HIGH ZIG ZAG -- SINGLE PHASE (SERIES) CONNECTION



VOLTAGE (HIGH ZIGZAG)		
Hz	**L-L**	**L-N**
60	480	240
	460	220
50	415	208
	380	190

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

DEDICATED SINGLE PHASE CONNECTION
HIGH VOLTAGE - SERIES CONNECTED



VOLTAGE (DEDICATED)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110
	200	100

OPERATION

PRE-START INSPECTION

Before starting the generator for the first time, the following inspection checks are recommended:

1. A visual inspection should be made for any loose parts, bad connections, or foreign materials.

2. Bar the set over by hand for at least 2 revolutions to be sure that there is no interference and that the set turns freely. If the set does not turn freely, check for clearance in the generator and exciter air gap.

3. Check all wiring against the proper connection diagrams, and ensure that all connections and terminations are tight and properly insulated.

WARNING

MAGNAPLUS GENERATORS MAY HAVE VOLTAGE PRESENT AT THE LEAD TERMINALS WHEN THE SHAFT IS ROTATING. DO NOT PERMIT OPERATION OF THE GENERATOR UNTIL ALL LEADS HAVE BEEN CONNECTED AND INSULATED. FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE

4. Verify that all equipment is properly grounded (earthed).

5. Clear the surrounding area of any materials that could be drawn into the generator.

6. Check all fasteners for tightness.

7. Check all access plates, covers, screens and guards. If they have been removed for assembly or inspection, reinstall and check for security.

8. Review all prime mover prestart-up instructions, and ensure that all recommended steps and procedures have been followed.

9. Remove any masking materials affixed during painting. Inspect the generator, prime mover, and any accessory equipment to ensure that nameplates, and all safety warning / caution signs and decals provided with the equipment are in place and clearly visible.

Note: It is strongly recommended that the authority having jurisdiction over the installation site be consulted to determine if any additional warning or caution notices, or additional safety devices are required by local codes / standards. Any such required notices or devices should be installed prior to initial startup.

START-UP

The following procedure should be followed when starting the generator set for the first time.

1. The generator output must be disconnected from the load. Be sure that the main circuit breaker or fused disconnect is in the open position.

2. Open the input power to the automatic voltage regulator. Remove the fuse or disconnect and insulate one of the regulator input power leads. (See separate regulator manual)

3. Verify that all prime mover start-up procedures have been followed.

4. If the unit is provided with space heaters, ensure that they are de-energized. In some installations, a set of auxiliary contacts on the main circuit breaker or transfer switch will automatically open the space heater circuit when the generator is connected to the load.

5. Start the prime mover, and adjust it for proper speed. See generator nameplate.

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6. The purpose of this initial test with the regulator out of the circuit is to detect any wiring mistakes without exposing the unit to undue risk. Check all line to line and line to neutral voltages for balanced voltage. If voltages are balanced, shut down the set and reconnect the regulator. If voltages are unbalanced, shut down the equipment and check for improper wiring. If the problem persists, consult the factory.

With the regulator de-energized, the residual voltage should be 10 - 25% of rated value. It is recommended that this residual voltage and driver RPM be recorded for use as a future troubleshooting benchmark.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

7. Start the set and adjust the terminal voltage to the desired value by means of the regulator voltage adjustment. If the regulator is equipped with a stability adjustment, follow the instructions in the regulator manual to adjust the stability. Again, check all line to line and line to neutral voltages for balance. It is recommended practice to record the no load excitation (DC voltage to the exciter stator), generator terminal voltage, and driver speed as a benchmark for future troubleshooting.

8. Close the main circuit breaker to the load.

9. Monitor the generator output current to verify that it is at or below nameplate value.

10. Check generator speed (frequency) under load. Adjust as necessary. (Refer to prime mover or governor manuals)

SHUTDOWN PROCEDURE

There are no specific instructions for shutting down the generator; however, several good practices should be observed to prolong equipment life.

1. It is advisable to disconnect all loads (open main circuit breaker or disconnect) prior to shutdown. This is especially important if loads can be damaged by low voltage or low frequency conditions during generator "coast down".

2. Isolate all conditions that could apply voltage to the generator terminals while the generator is at rest. Failure to comply could result in personnel injury or equipment damage.

3. If the unit is equipped with space heaters, verify that the heater circuit is energized.

MAINTENANCE

The following maintenance procedures should be followed to ensure long equipment life and satisfactory performance. Maintenance intervals will depend upon operating conditions.

1. Routinely check intake and exhaust air screens to ensure that they are clean and free of debris. Clogged intake air screens will reduce cooling air flow and result in higher operating temperatures. This will reduce generator life and may result in generator damage.

2. All MagnaPLUS generators are equipped with double shielded ball bearings lubricated for the life of the bearing. Every 1,000 hours check the bearing(s) for smooth, quiet operation. For continuous duty generators, recommended practice is to replace the bearing during major overhauls of the engine.

3. Periodically inspect the unit for any buildup of contamination (dirt, oil, etc.) on the windings. If the wound components have become coated with heavy concentrations of oil and grime, the unit should be disassembled and thoroughly cleaned. This operation is not one that can be accomplished effectively on site, but rather one that should be conducted by an authorized service center equipped with the appropriate apparatus and solvents necessary to properly clean and dry the generator.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

4. Every 2,000 operating hours or in conjunction with scheduled engine maintenance, check the DC no load excitation voltage per item #7 in the startup procedure. Compare this voltage with the value recorded during initial startup. If this value of no load excitation voltage is markedly higher than the bench mark reading, it is an indication of problems in either the exciter, main field,

or the rotating rectifier assembly. Ensure that RPM is the same as initial test.

5. Monitor and record insulation resistance with a 500 volt mega-ohm meter. The minimum acceptable reading is 2 mega-ohms. If the reading drops below the minimum, the generator should be cleaned and dried at an authorized service shop. Consult Marathon Electric for more information.

DRYING WINDINGS

Generators in service may inadvertently have their windings exposed to splashing or sprayed water. Units that have been in transit or storage for long periods of time may be subjected to extreme temperature and moisture changes causing excessive condensation. Regardless of the source of moisture, wet windings should be thoroughly dried out before operating the unit. If this precaution is not taken, serious damage to the generator can result. The following procedures may be utilized in drying the generator's windings. The method selected will be influenced by winding wetness and situation limitations.

Space Heaters
An electric heater may have been supplied with the generator. When energized from a power source other than the generator, the heater will gradually dry the generator. This process can be accelerated by enclosing the unit with a covering and inserting additional heating units. A hole should be left at the top of the covering to permit the escape of moisture. Care should be taken not to overheat various accessory equipment mounted with the generator.

Forced Air
Another method to dry the generator is to run the set with no excitation (see startup procedure item #2). The natural flow of ambient air through the generator will tend to dry the windings. This method can be accelerated by adding a source of heat at the air intake to the generator. Heat at point of entry should not exceed 80 C (180° F).

TESTING

Visual Inspection

Remove covers and look for any obvious problems: burnt windings, loose connections, broken wires, frayed insulation, cracked brackets, missing hardware, etc. Check for foreign objects which may have been drawn into the generator. Verify that the generator's air gaps (main rotor and exciter) are free from obstructions. If possible, rotate the generator manually to ensure free rotation. Never "bar over" the engine generator set using the generator fan.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

CONSTANT EXCITATION TEST (12V BATTERY TEST)

The generator "no load" voltage is dependent on exciter input voltage and generator speed. With the generator operating at rated speed and 12 volts dc applied to the exciter field, the generators terminal voltage will be near rated value.

1. Shutdown the generator set and connect a voltmeter on the generator terminals.

2. Disconnect the regulator's F+ (F1) and F- (F2) leads and connect them to a 12V battery. Caution should be taken to ensure that the battery is not exposed to any potential arcing.

3. With no load on the generator (main breaker open) run the generator at rated speed. Measure the generator's terminal voltage and compare this value with values recorded during installation.

If voltage readings are normal, the main generator and excitation are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes, surge suppressor, and windings.

Continuity / Resistance Test

The generator has four components which can be checked using an ohm meter: exciter stator, exciter rotor, main stator and main rotor. Each of these components are comprised of various windings which form a complete electrical path of relatively low resistance. Using an ohm meter measure the loop resistance of each component. Compare these measured values with the values listed in the specification section of this manual. Note that very small resistance values require precision equipment to make accurate measurements; however, a standard ohm meter will provide a good indication of winding continuity.

Insulation Test

Insulation resistance is a measure of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or be degraded by contaminants: dust, dirt, oil, grease, and especially moisture. Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shutdown

Insulation resistance is measured with a megger (mega-ohm meter). A megger measures insulation resistance by placing 500 volts between the winding and the frame of the generator. Caution must be taken to remove all electronic devices (regulators, diodes, surge protectors, capacitors, protective relays, etc.) from the winding circuit before checking the insulation. Winding insulation can be checked on the main stator, main rotor, exciter stator, and exciter rotor. Minimum resistance is 2 mega-ohms. If the winding resistance is low it must be dried (see maintenance section) or repaired.

DIODE TESTING

If the generator is close coupled to an engine, it may be necessary to "bar over" the engine in order to gain access to a given area of the rectifier assembly. **NEVER** use the generator's fan as a fulcrum to accomplish this. Use the engine manufacturer's recommended practice to manually turn over the engine. To prevent possible injury to personnel, and damage to the equipment, ensure that the engine cannot start during this procedure.

Remove the two main rotor leads and the three exciter rotor leads from the rectifier assembly (figure 4). The rectifier assembly is now electrically isolated from the generator. The diodes remain mounted and the diode leads remain connected to the terminal posts. Using an ohmmeter or a battery light continuity tester, place one test probe on the diode lead terminal post. In succession, touch the other test probe to the lead screw hole in each heat sink. Reverse the probes and repeat the procedure. You have now tested the three diodes connected to this terminal post in both the forward and reverse direction. Repeat the procedure using the other diode terminal post.

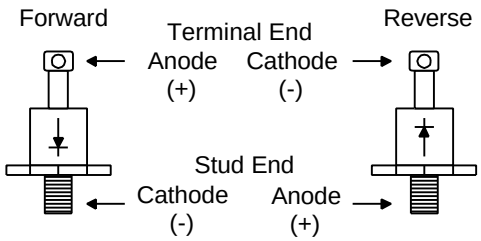


FIGURE 3: DIODE POLARITY

When the positive test probe is connected to the diode's anode and the negative test probe is connected to the diode's cathode (forward biased), the diode will switch on and conduct electricity (figure 3). This is observed by a low resistance reading when using an ohm meter or the lighting of the bulb when using a battery light continuity tester. Reversing the test leads (reverse biased) will result in the diode switching off and no electricity will be conducted. The results of these tests should indicate one of three conditions:

1. **Good diode:** Will have a much greater resistance in one direction than the other. Typical reverse biased resistance will be 30,000 ohms or greater, while forward biased resistance will be less than 10 ohms. The battery-light tester will have the light "on" in one direction and "off" in the other.

2. **Shorted condition:** Ohmmeter reading will be zero, or very low in both directions. The continuity tester will have the light "on" in both directions.

3. **Open condition:** Ohmmeter will have a maximum (infinity) reading in both directions. Continuity tester light will be off in both directions.

Diode failure after a 25 hour "run-in" period is generally traceable to external causes such as a lightning strike, reverse current, line voltage spikes, etc. All 6 diodes are essentially in the same circuit. When a diode is stressed to failure, there is no easy method to determine remaining life in the other diodes. To avoid possible continued failures, it is recommended that the entire rectifier assembly be replaced rather than replacing individual diodes.

SERVICE

GENERAL

The service procedures given in this section are those which can reasonably be conducted on-site with a minimum number of special tools and equipment. All service procedures should be conducted by qualified maintenance personnel. Replacement parts may be ordered through an authorized service center or directly from the factory**.**

FIELD FLASHING

Restoring Residual Magnetism
(not applicable on PMG equipped generators)

To restore residual magnetism to the generator, connect a 12 volt battery to the exciter field while the generator using the following procedure:

1. Shutdown the generator set. Remove the exciter field leads F+ and F- from the regulator.

CAUTION:

Failure to remove the exciter field leads from the automatic voltage regulator during flashing procedures may destroy the regulator.

2. Connect the F+ and F- leads to the battery's corresponding positive and negative terminals. This should be done using an appropriate length of lead wire to separate the battery from the point of connection (batteries may explode when exposed to an electric arc). After 3 to 5 seconds, remove the F- lead. An inductive arc should result. If no arc is drawn, repeat the procedure.

3. Reconnect the F+ and F- leads to the regulator. Restart the generator and verify that terminal voltage is developed. If terminal voltage does not develop, repeat the field flashing procedure and / or consult the trouble shooting section.

BEARING REMOVAL

Prior to performing this operation, it is suggested that the alternator's shaft be rotated until two of the main rotor poles are in a vertical position. Once the bearing bracket is backed out, the rotor will drop on the main stator core. Having the rotor in this position will limit the amount of rotor drop to that of the air gap. Visually inspect the bearing bore for damage or wear. If worn or damaged, replace prior to reassemble.

Opposite Drive End Bearing Bracket Removal.
Prior to proceeding with bracket removal, disconnect exciter field leads F+ and F- from the automatic voltage regulator and ensure that they are free to move when the bearing bracket is removed. Remove the bearing bracket retaining bolts. Using a pair of screw drivers, wedge the bracket off the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame and will drop until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore and o-ring (if equipped) for damage or wear. If worn or damaged, repair or replace prior to reassembly.

Drive End Bearing Bracket Removal,
Two Bearing Units.
Remove any drive arrangement from the generator shaft extension. Remove the bearing lock ring retaining screws. There is no o-ring in the drive end bearing bracket. The shaft extension must be supported before proceeding further. A hoist and sling, jack, or some other means of support with a capacity of 2 tons should be used.

Remove the bearing bracket retaining cap screws. Using a flat bladed screw driver or chisel, pry the bracket back from the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame. Lower the shaft extension until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore for damage or wear. If worn or damaged, sleeve or replace prior to reassembly.

Reassembly note: Before the bearing bracket is seated against the frame, a threaded rod may be used to help align the inner bearing cap with the bearing bracket.

BEARING REPLACEMENT

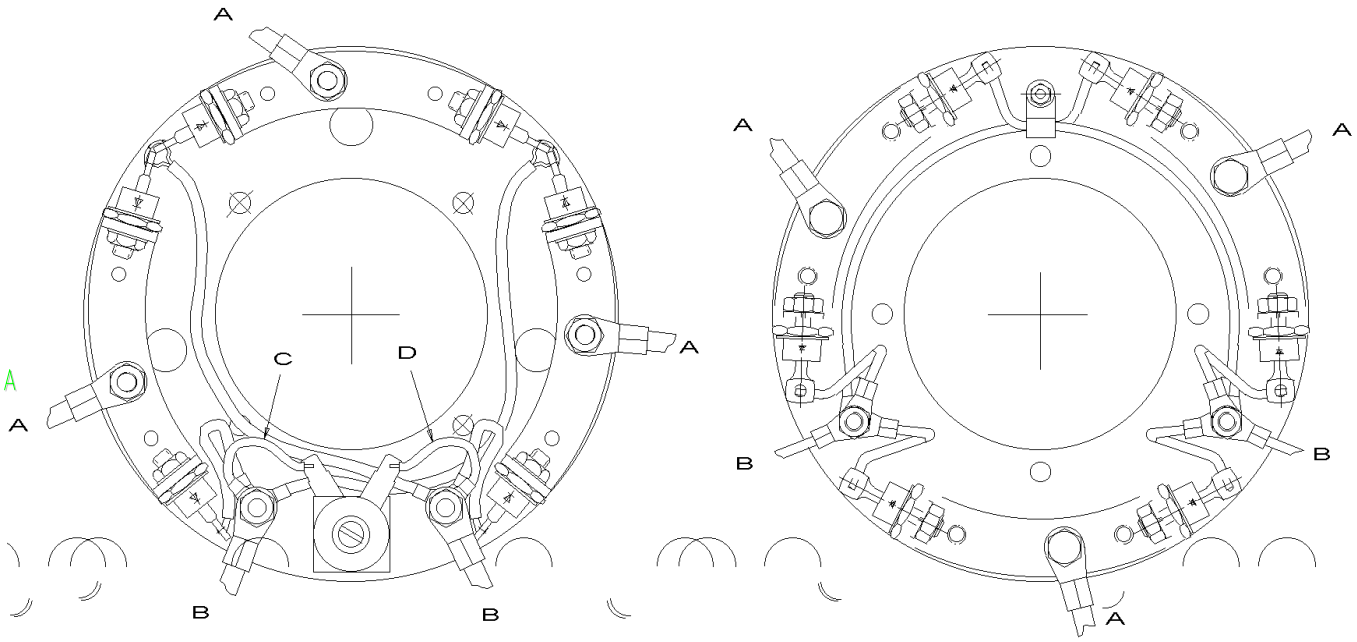
Using a bearing puller, remove the existing bearing. It is strongly recommended that the bearing be replaced any time the it is removed from the shaft. **ALWAYS** install the same type and size bearing that was supplied as original equipment. Order by part number from the parts list, and include the unit serial number and part number when ordering. Heat the bearing to a maximum of 100^{O}C (212^{O}F) in an oven. Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. The bearing should slide on the shaft and be seated without excessive force. Should the bearing bind on the shaft prior to being seated against the shoulder, a piece of tubing slightly larger than the press fit area can be used to drive the bearing to its final position. Using light taps with a soft mallet, apply pressure to the inner race only.

RECTIFIER ASSEMBLY REMOVAL

The rectifier assembly cannot be removed until the opposite drive end bearing bracket and bearing have been removed (see bearing removal procedure). Remove the three exciter rotor leads from the heat sinks and the two main rotor leads from the main rotor posts (see Figures 4). Remove the screws securing the rectifier assembly and pull the assembly free from the shaft.

DIODE REPLACEMENT

Prior to installing a replacement diode on the heat sink, apply a thin film of conductive heat sink compound around the base of the diode (do not coat the threads). When installing a diode on the heat sink, care should be taken not to over torque the retaining nut which could cause damage to the device. Torque to 28 pound-inches. If not damaged, the existing diode lead wire may be unsoldered from the failed diode, and resoldered on the replacement.



430 FRAME **280 / 360 FRAME**

A - Exciter Rotor Lead, B - Main Rotor Lead, C - Red (+) Suppressor Lead, D - Black (-) Suppressor Lead

FIGURE 4: ROTATING RECTIFIER ASSEMBLY

RETURNED GOODS

Contact Marathon Electric Manufacturing Corporation for authorization before returning any product. We can not be responsible for any items returned without authorization.

CAUTION

Single bearing generators must have their rotor assembly properly secured to prevent damage during transit to the factory, or to an authorized service center.

TROUBLESHOOTING

This section is intended to suggest a systematic approach to locating and correcting generator malfunctions. The section is arranged according to the symptoms of the problem. The steps have been arranged in an attempt to do the easy checks first and prevent further damage when troubleshooting a disabled machine.

The first step of troubleshooting is to gather as much information as is possible from operating personnel and individuals present during the failure. Typical information includes: how long the unit had been operating; what loads were on line; weather conditions; protective equipment that did or did not function. In addition, information as to the operating condition of the generator's prime mover is vital. Has the prime mover been maintaining constant speed? If not, have there been extended periods of under speed operation? Has the prime mover experienced an over-speed condition? If yes, what was the maximum speed, and how long did the unit operate at that elevated speed?

The generator speed should be maintained at rated nameplate value during all operating tests. The frequency of the generator depends upon rotational speed. Most regulators used with MagnaPLUS generators have built in under frequency protection such that if the speed is reduced more than 5%, the voltage will drop off rather rapidly with further reductions in speed.

WARNING

HIGH VOLTAGES MAY BE PRESENT AT THE GENERATOR'S TERMINALS WHEN THE UNIT IS RUNNING. SOME ACCESSORY EQUIPMENT SUCH AS SPACE HEATERS MAY BE ENERGIZED FROM AN OUTSIDE POWER SOURCE WHEN THE UNIT IS AT REST. TOOLS, EQUIPMENT, CLOTHING AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS. SPECIAL PRECAUTIONS MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE REMOVED OR DISABLED TO GAIN ACCESS AND PERFORM TESTS. BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

GENERATOR PRODUCES NO VOLTAGE

CAUSE	CHECK AND REMEDY
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for loose connections, open circuits, grounds, and short circuits.
Loss of residual	Flash the field. Refer to field flashing in the service section. If the generator is equipped with a PMG, field flashing is not necessary -- check regulator fuse and input power from the PMG.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator protection operating	Adjust regulator. Consult regulator manual.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE, NO LOAD

CAUSE	CHECK AND REMEDY
Underspeed operation	Check speed using a tachometer or frequency meter.
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for grounds, open circuits and short circuits.
Loss of regulator power	Check regulator fuse and input power. Input power is produced by the generator's residual voltage or from an optional PMG.
Regulator adjustment	Adjust regulator settings. Consult regulator manual.
Regulator incorrectly connected	Review the generator connection diagram or reference the regulator manual.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE WHEN LOAD APPLIED

CAUSE	CHECK AND REMEDY
Excessive load	Reduce load. The load on each leg should be evenly balanced, and rated current should not be exceeded on any leg.
Large motor starting or low load power factor	Motor starting currents are too large for the generator. When starting multiple motors, sequence the motors and start the largest motors first. Reduce lagging power factor load.
Driver speed droop or belt slip	Check driver. If belt driven, check belt tension. Check under frequency setting on regulator. Under frequency voltage roll-off may be activated.
Reactive droop	If the generator is equipped for parallel operation, some droop is normal as reactive load increases. When operating as a single unit, the parallel CT can be shorted to eliminate this effect. Refer to Regulator manual.
Line drop	If voltage is proper at generator terminals but low at load terminals, increase external wire size.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.

GENERATOR PRODUCES FLUCTUATING VOLTAGE

CAUSE	CHECK AND REMEDY
Fluctuating engine speed	Check engine and governor systems for malfunctions. Check load for fluctuation.
Regulator stability	Adjust Regulator stability. Refer to Regulator manual.
Regulator external rheostat	Replace defective or worn rheostat. Use shielded cable to minimize electrical noise.
Defective rectifier assembly	Check assembly for loose connections. Test the diodes as specified in the test section.
Loose terminal or load connections	Improve connections both mechanically and electrically.
Defective regulator	Replace regulator.

GENERATOR PRODUCES HIGH VOLTAGE

CAUSE	CHECK AND REMEDY
Faulty metering	Check voltage with separate meter at generator terminals.
Incorrect connections	Verify generator connections. Refer to drawings supplied with the generator or connection diagrams in this manual.
Regulator adjustments	Adjust regulator. Consult regulator manual.
Leading power factor	Check the power factor of the load. If power factor is leading, change load configuration. Excessive leading power factor (capacitors) can cause voltage to climb out of control.
Incorrect regulator connection	Verify regulator voltage sensing is connected correctly. Consult regulator manual.
Defective regulator	Replace regulator.

GENERATOR BUILDS VOLTAGE FROM STARTUP, THEN GOES TO LOW (RESIDUAL) VOLTAGE

CAUSE	CHECK AND REMEDY
Regulator protective circuit operating	Check indicators on regulator. Correct problems and adjust regulator as is required. Refer to regulator manual.

GENERATOR IS OVERHEATING

CAUSE	CHECK AND REMEDY
Generator is overloaded	Reduce load. Check with ammeter and compare with nameplate rating.
Clogged ventilating screens	Clean air passages.
High room temperature or altitude	Improve ventilation or reduce load.
Insufficient circulation of cooling air	Generator location and enclosure design must provide adequate air flow and minimize recirculation of hot air.
Unbalanced load	The load on each leg should be as evenly balanced as possible and should not exceed rated current on any one leg.

GENERATOR PRODUCES MECHANICAL NOISE

CAUSE	CHECK AND REMEDY
Defective bearing	Replace bearing.
Loose or misaligned coupling	Tighten, realign, or replace coupling.
Belt slap or loose guards	Check belt tensioning. Check belt guard fasteners.

EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR SET

CAUSE	CHECK AND REMEDY
Distorted voltage waveform	Analyze load. Excessive SCR (thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Marathon Electric..
Improper generator voltage or frequency	Check name plates of devices comprising the load. Compare required voltage and frequency with that of the generator. Adjust driver speed and/or generator voltage as necessary to match generator output to load requirements.

CAUTION: Compare required voltage, frequency, and KVA with generator nameplate to ensure adequate generator capacity. If in doubt, consult Marathon Electric for information regarding generator capacity.

SPECIFICATIONS

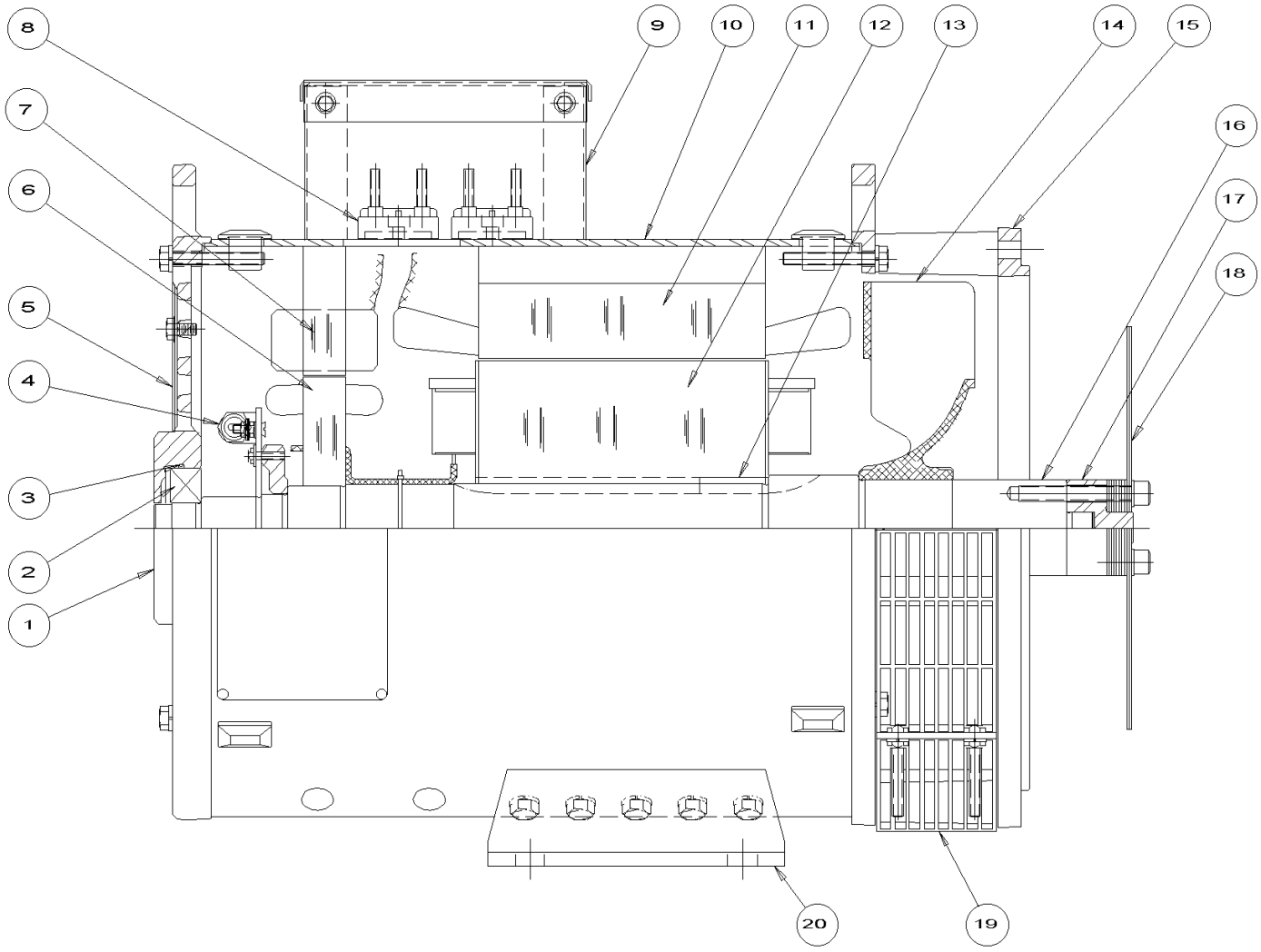
MODEL / FRAME SIZE	EXCITER RESISTANCE	
	STATOR	ROTOR
281, 282, 283, 284	23.0	.120
361, 362, 363 -- three phase	23.5	.120
361, 362, 363 -- dedicated single phase	23.0	.135
431, 432, 433 -- three phase	20.33	.076
431, 432 -- dedicated single phase	18.0	.105

MODEL	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS 480 V / 60 HZ	NO LOAD TERMINAL VOLTAGE WITH 12 VDC FIXED EXCITATION	
	STATOR*	ROTOR		HIGH WYE / 60 HZ	HIGH WYE / 50 HZ
281PSL1500	4.20	.400	11.0	485	400
281PSL1501	4.15	.400	11.0	490	404
281PSL1502	3.20	.439	9.0	528	435
282PSL1503	2.00	.470	10.4	500	415
282PSL1504	1.51	.512	11.3	490	400
282PSL1505	1.00	.575	10.1	515	415
283PSL1506	.681	.654	11.0	495	400
283PSL1507	.480	.758	12.0	480	390
284PSL1508	.346	.875	12.0	480	375
361PSL1600	.381	.750	11.8	485	400
361PSL1601	.264	.810	12.5	475	385
361PSL1602	.181	.990	14.1	460	370
362PSL1604	.138	1.05	12.2	480	380
362PSL1606	.0980	1.20	10.8	500	405
363PSL1607	.0692	1.37	12.2	475	380
431PSL6202	.0214	.8114	15.1	440	360
431PSL6204	.0477	.6373	13.6	455	385
431PSL6206	.0371	.6793	13.82	455	370
431PSL6208	.0133	.715	12.20	475	390
432PSL6210	.0214	.8114	15.1	440	360
432PSL6212	.0226	.8656	14.1	445	385
433PSL6216	.01215	1.0672	16.2	425	345
433PSL6220	.01214	.9743	15.6	430	350

* Stator resistance measured line to line in a high wye connection.

DEDICATED SINGLE PHASE	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS / 60 HZ
	STATOR	ROTOR	
281PSL1511	1.420	.381	8.3
281PSL1512	1.106	.395	8.1
281PSL1513	.632	.430	8.7
282PSL1514	.436	.450	9.2
282PSL1515	.240	.520	9.7
283PSL1516	.160	.620	13.3
284PSL1517	.0918	.760	12.2
284PSL1518	.0610	.857	16.6
361PSL1611	.0695	.750	17.5
361PSL1612	.0434	.857	16.1
361PSL1613	.0369	.926	13.6
362PSL1615	.0191	1.20	17.0
363PSL1617	.0119	1.35	23.0
431PSL1811	.0248	.516	9.9
431PSL1813	.0129	.615	13.8
432PSL1814	.00931	.643	15.1
432PSL1815	.00723	.852	11.2

PARTS LIST – SINGLE BEARING
Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	Mounting Adapter (SAE)
6	Exciter Rotor	16	Shaft
7	Exciter Stator	17	Drive Hub
8	Link Board (terminal block)	18	Drive Disk (SAE)
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown.
The generator model and serial numbers are required when ordering parts.

MARATHON ELECTRIC
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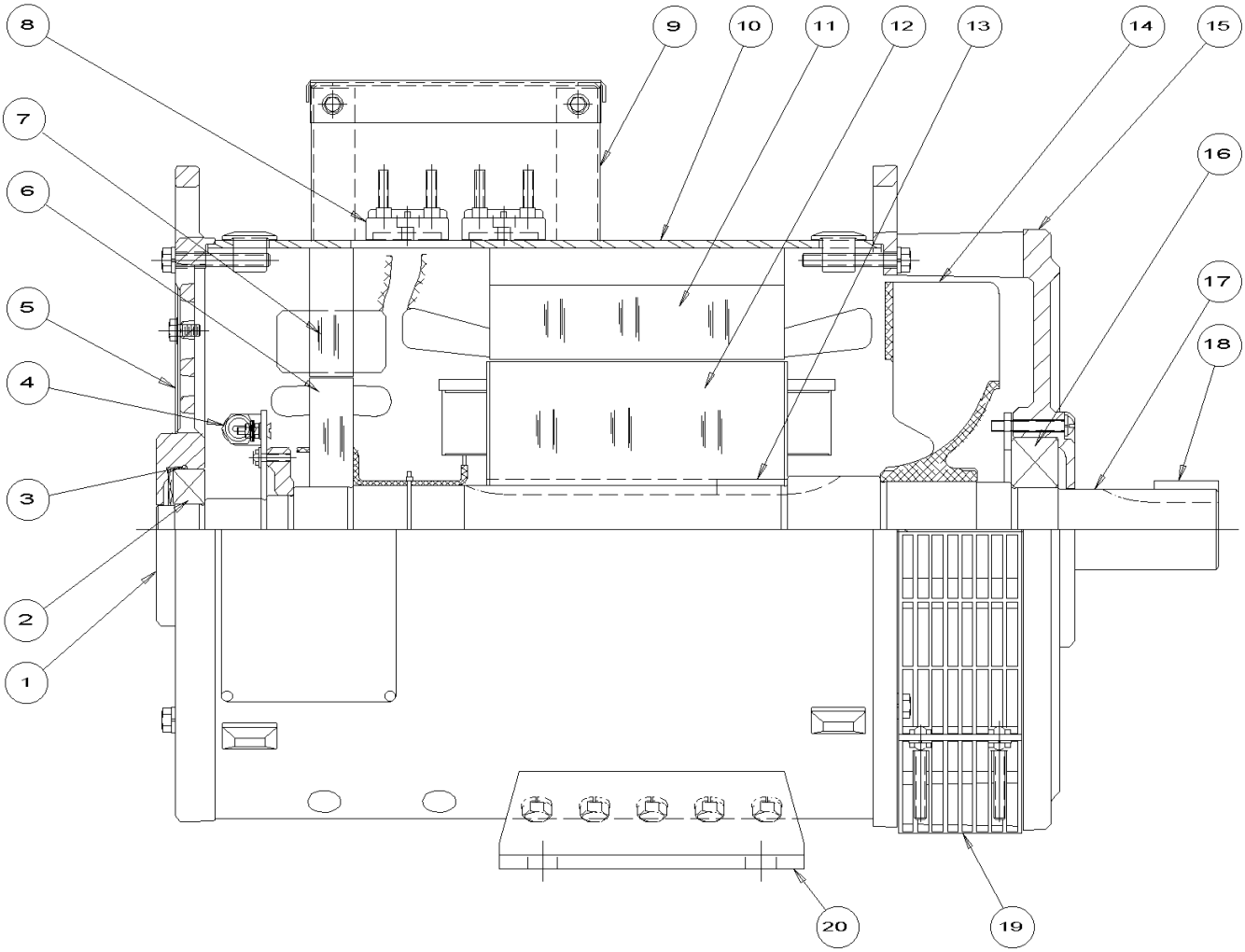
PARTS LIST – DUAL BEARING
Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing (nondrive end)	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	End Bracket (drive end)
6	Exciter Rotor	16	Bearing (drive end)
7	Exciter Stator	17	Shaft
8	Link Board (terminal block)	18	Key
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

SE350

VOLTAGE REGULATOR

INSTRUCTION MANUAL

MARATHON® ELECTRIC

A Subsidiary of Regal-Beloit Corporation

INTRODUCTION

The SE350 voltage regulator is an encapsulated electronic voltage regulator that controls the output of a brushless AC generator by regulating the current into the exciter field.

SPECIFICATION	SE350 REGULATOR
Sensing & Power Input	190-240 Vac
Burden	500 VA
Output Power- Continuous	73 Vdc at 3.5 Adc (255w)
Output Power - Forcing(240 Vac Input Power)	105 Vdc at 5 Adc (525w)
Regulation	1 .0%
Remote Voltage Adjustment Range	± 10% with 2000 ohm rheostat ± 5% with l000 ohm rheostat
Frequency Compensation	Adjustable
Roll off frequency	54-61 Hz for 60 Hz 45-51 Hz for 50 Hz
Operation	Weight6.5 oz.
Operating Temperature	- 40°C to + 60°C
Storage Temperature	- 65°C to + 85°C
Power Dissipation	8 watts maximum
Size	3.94" L X 2.66” W X 2.20: H
Voltage Buildup	Internal provisions forautomatic voltage build up from generator residual voltage as low as 10 Vac.
EMI Suppression	Internal Electromagnetic Interference Filter (EMI Filter)

WARNING

TO PREVENT PERSONAL INJURY OR EQUIPMENTDAMAGE
ONLY QUALIFIED PERSONNEL SHOULD
INSTALL, OPERATE, OR SERVICE THIS DEVICE.

CAUTION: DO NOT megger or high-pot the generator with the regulator connected.
DO NOT high-pot the regulator.

The SE350 voltage regulator can be mounted in any plane, following are mounting dimensions.

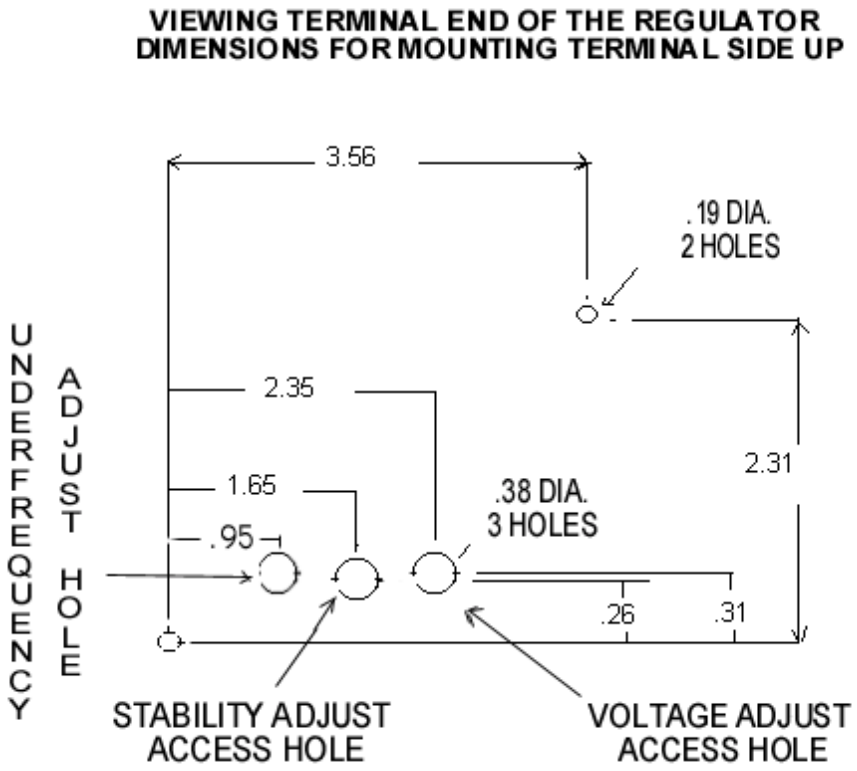


FIGURE 1

FUSE

A 4 Amp, 250 V, 5 X 20 mm fuse is supplied with the regulator (Part A-527066).
It can be located on the rear face of the voltage regulator.

EXCITER POWER CIRCUIT

Connect the regulator wire F+ to the generator F+ or Fl field terminal.
Connect the regulator wire F- to the generator F- or F2 field terminal.
See Figure 2 for typical connection diagram

SENSING/POWER INPUT CIRCUIT

Input power and sensing is achieved through terminals 3 and 4.
The voltage input requirement of the SE350 is 190 to 240 Vac. See Figure 2

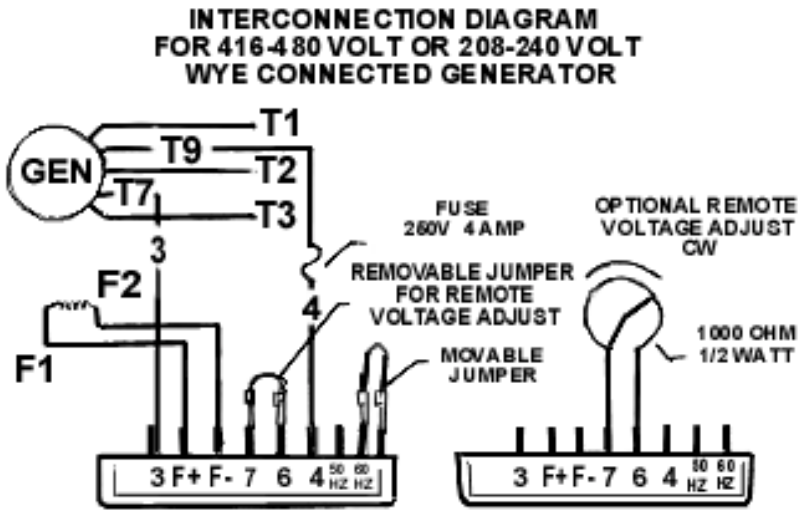


FIGURE 2

VOLTAGE ADJUST

The screwdriver adjustable potentiometer adjusts the generator output voltage. Adjustment clockwise increases the generator output voltage.

When using a remote voltage adjust rheostat, remove the jumper wire across terminals 6 and 7 and install a 2000 ohm 1/2 watt (minimum) rheostat. This will give ±10% voltage variation from the nominal. (For ±5% voltage variation use a 1000 ohm 1/2 watt rheostat). See Figure 2.

STABILITY ADJUST

System stability is the ability of the generator to respond to load transients. Decreasing the stability makes the generator less sluggish and faster to respond to toad transients. If the stability of the regulator is decreased too much, the generator will tend to hunt under steady state conditions.

The screwdriver adjustable potentiometer adjusts the system stability. Adjustment clockwise increases the stability. Increasing the stability increases the response time of the generator. Conversely, decreasing the stability decreases the response time of the generator.

V/HZ ROLL-OFF FREQUENCY SELECTION

The roll off point is the frequency where the generator voltage starts to decrease. This reduces the Kilowatt load to the engine, which allows the engine to recover in speed under any load transient condition. Use jumper to select 50 HZ or 60 Hz. The screwdriver adjustable potentiometer sets the roll-off frequency from 54-61 Hz in the 60 Hz setting or from 45-51 Hz in the 50 Hz setting.

The SE350 has the roll-off point preset to 58 Hz in the 60 Hz mode and 48 Hz in the 50 Hz mode. To change the roll-off point, adjust engine speed to the desired rated speed. (50 or 60 Hz). Set the voltage to the desired setting at rated speed. Adjust engine speed to the desired roll-off point. Turn the potentiometer counterclockwise until the voltage starts to drop off. Then adjust the potentiometer clockwise until the voltage returns to rated voltage. Re-adjust engine speed to rated speed.

PRELIMINARY SET-UP

Ensure the voltage regulator is correctly connected to the generator. Refer to the specific connection diagram supplied with the generator.

Set the regulator voltage adjust to full counter-clockwise (minimum voltage level).

Set the remote voltage adjust (if used) to the center position.

Set the stability control full clockwise (maximum stability level).

Connect the positive lead of a 100 V D.C. voltmeter to Fl and the negative lead of the voltmeter to F2 or use an appropriate AC voltmeter on the generator output leads.

SYSTEM START-UP

Start and run the generator at no load and rated speed. The generator voltage should build up to a minimum level. (Actual level is dependent upon connection). If it does not build up, refer to field flashing section in generator manual.

Slowly adjust the voltage control until the generator voltage reaches the nominal value. If used, adjust the remote voltage rheostat to set the generator voltage to the exact value desired.

Turn the stability adjust counter-clockwise until instability is shown on either of the voltmeters mentioned in the “PRELIMINARY SET-UP” section. With the system operating in an unstable condition, slowly adjust the stability control clockwise until generator stability is reached.

Interrupt regulator power for a short time (approximately 1-2 seconds).

If the generator remains stable, no further adjustment is necessary. If the generator does not remain stable, increase the stability slightly and interrupt regulator power again.

This procedure should be repeated until system stability is reached and maintained.

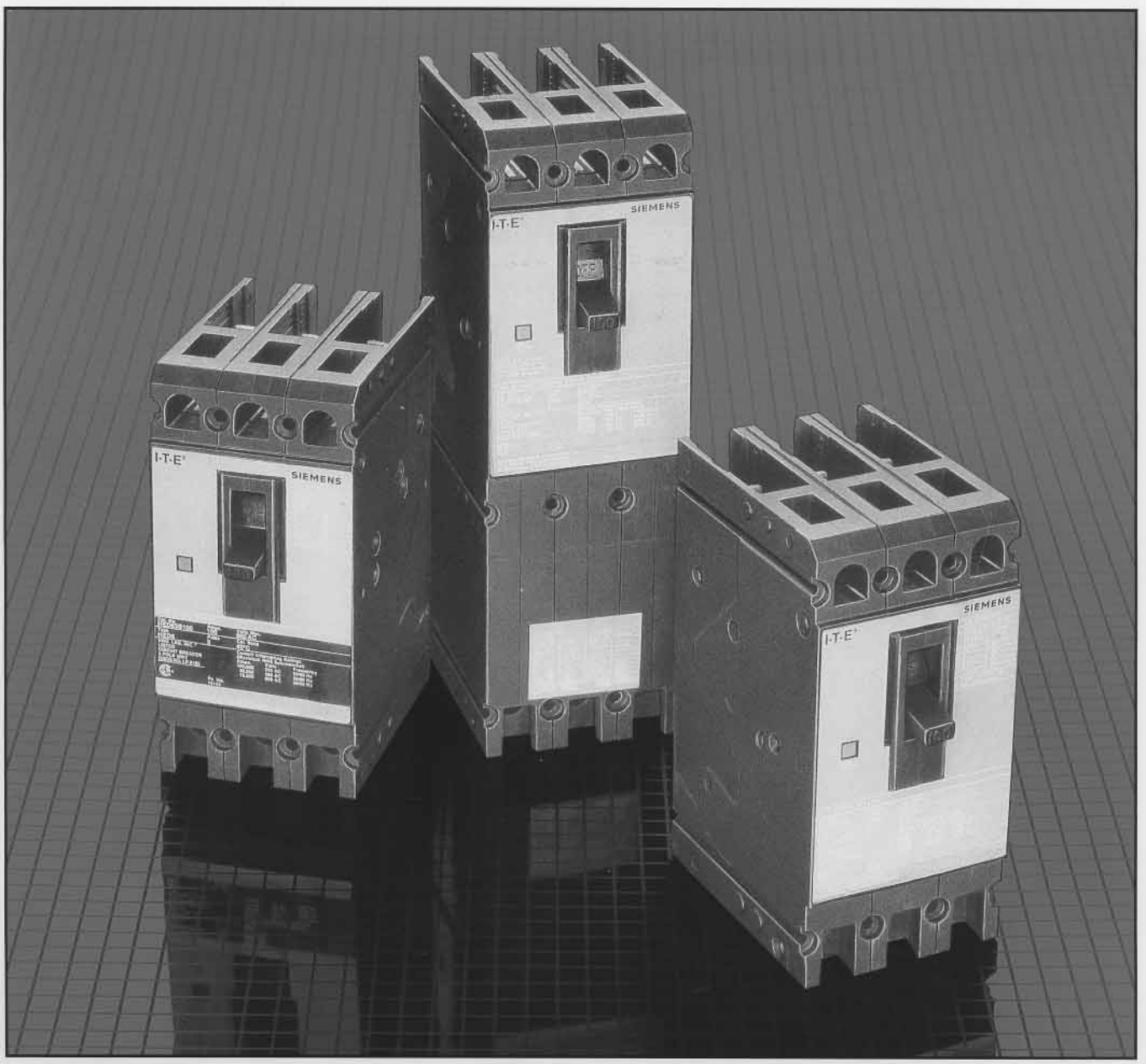
TROUBLESHOOTING

Symptom	Cause	Action
Residual Voltage -No Output	Residual voltage at regulator power input wires 3 & 4 below 10 V ac.	Check wiring diagram for proper connections. Flash generator field. Refer to field flashing section in generator manual.
	Acceleration time to rated speed too long.	Reduce acceleration time. Interrupt power input to regulator after achieving rated speed.
	Field leads Fl, F2 not connected.	Connect field leads Fl, F2.
	Power input leads not connected.	Connect power-input leads 3,4.
	Blown or missing fuse.	Replace fuse.
	Defective regulator.	Replace regulator.
	Defective generator.	Consult generator manual.
Output Voltage Low	Incorrect connections.	Check wiring diagram for proper connections.
	Voltages adjust turned down.	Rotate voltages adjust CW until desired voltage is reached.
	Remote voltage adjust is turned down.	Rotate remote voltages adjust CW until desired voltage is reached.
	Defective regulator.	Replace regulator.
Output Voltage High	Voltages adjust turned too high.	Rotate voltages adjust CCW until desired voltage is reached.
	Remote voltage adjust is turned too high.	Rotate remote voltages adjust CCW until desired voltage is reached.
Output Voltage High - No Adjustment	Defective regulator.	Replace regulator.
Remote Voltage Adjust Operates Backwards	Voltages adjust wire backwards.	Reverse the wiring of the remote voltage adjust.
Generator Output Voltage Hunting	Stability adjusts not set properly.	Rotate the stability adjusts in a CW direction until hunting stops.
Poor Regulation	Defective regulator.	Replace regulator.

SIEMENS

I-T-E® Molded Case Circuit Breakers

ED-Frame Information and Instruction Guide



⚠ DANGER

Hazardous voltages are present inside the enclosures or panels in which the circuit breakers are installed. Death, serious injury, and/or equipment damage will result if circuit breakers are improperly applied or precaution is not used.

De-energize all incoming power prior to installation of circuit breakers or associated accessories.

Only qualified personnel should work on or around this equipment.

Position of circuit breaker handles shown in this booklet is for illustration purposes only. Circuit breakers are to be installed in OFF or TRIPPED position only.

I-T-E® ED-Frame Circuit Breakers 1, 2 and 3-Pole, 15-125 Amperes

Types ED2, ED4, ED6, HED4, HED6, HHED6 CED6, ED6-ETI, CED6-ETI

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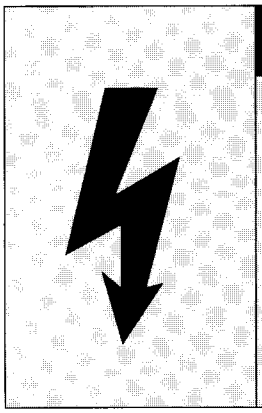
NOTE: Information related to specific frame types or catalog numbers does not guarantee product availability. Technical information may change due to product revisions. Consult Siemens sales office concerning any variation of product information contained herein.



⚠ DANGER

Hazardous voltages are present in the equipment which will cause death or severe personal injury and product failure. Always de-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which can cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

IMPORTANT

The information contained herein is general in nature and is not intended for specific application purposes not is it intended as a training manual for unqualified personnel. Refer to Note for definition of a **qualified person.*** It does not relieve the user of responsibility to use sound practices in application, installation, operation and maintenance of the equipment purchased or in personnel safety precautions. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence. Siemens Energy & Automation, Inc. reserves the right to make changes in specifications shown herein or add improvements at any time without notice or obligation.

NOTE

***Authorized and qualified personnel–**
For the purpose of this manual a qualified person is one who is familiar with the installation, construction or operation of the equipment and the hazards involved. In addition, he has the following qualifications:

(a) **is trained and authorized** to de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
(b) **is trained** in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
(c) **is trained** in rendering first aid.

SUMMARY

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local sales office, listed on back of this instruction guide.

The contents of this instruction manual should not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Energy & Automation, Inc. The warranty contained in the contract between the parties is the sole warranty of Siemens Energy & Automation, Inc. Any statements contained herein do not create new warranties or modify the existing warranty.

Information and Instructions

General Information

General

ED-Frame Sentron™ Series circuit breakers, as shown on pages 5-9, are for use in individual enclosures, switchboards, panelboards and load centers. They are available as thermal magnetic trip (types ED2, ED4, ED6, HED4, HED6, HHED6, CED6), current limiting (type CED6) instantaneous magnetic trip only (motor circuit protection—types ED6-ETI, CED6-ETI) and molded case switches (types ED2, ED4, ED6, HHED6, CED6).

CED6 type Sentron™ Series circuit breakers combine thermal magnetic construction for overload protection and an additional set of patented "blow-apart" contacts in conjunction with the ED-Frame's standard patented "blow-apart" contacts. This arrangement provides for current-limiting protection under high fault interrupting conditions as outlined in the National Electric Code, Article 240-1① and UL 489② standards. CED6 type ED-Frame circuit breakers are fuseless and therefore require no blown fuses to be located and replaced should a high current fault occur. The common trip feature of the circuit breaker is completely retained so that all poles of the circuit breaker open when caused to trip due to an overload or short circuit.

Pressure wire connectors, suitable for use with aluminum or copper wire are available for all ED-Frame circuit breakers. Rear connection studs or plug-in connector assemblies are also available (1, 2 and 3-pole). The latter mounting arrangement permits removal of the circuit breaker from its leads without physically coming in contact with either the line or load terminals. Special features such as a shunt trip, auxiliary and alarm switches and undervoltage trip devices are available for field adaptation. The installation and/or removal of these devices is to be accomplished by qualified personnel only. These devices are mounted externally and Underwriters Laboratories listed, page 53. Information concerning them is found on pages 16-19 and 51.

Thermal Magnetic

ED2, ED4, ED6, HED4, HED6, HHED6, CED6 type circuit breakers provide complete overload and short circuit protection by use of a time delay thermal trip element and an instantaneous magnetic trip element. Fixed instantaneous trip values are shown in the table below:

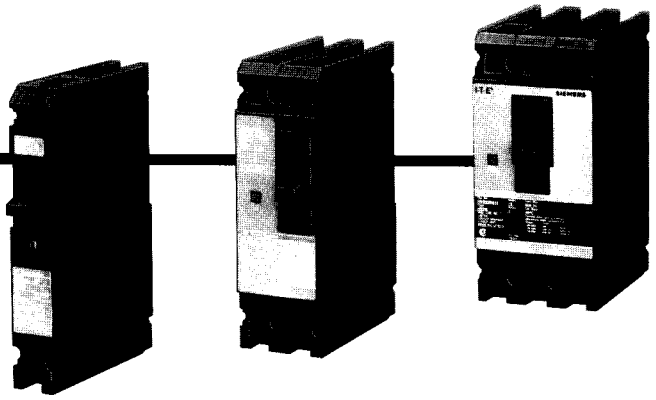
Fixed Instantaneous Trip

Ampere Rating	Fixed Instantaneous Band
15-25	400-700
30-125	600-1000

Circuit breakers are calibrated at the factory, under controlled temperature conditions for application at 40°C (104°F) ambient, to meet requirements as outlined in UL-489 standard for molded case circuit breakers. Catalog information is found on pages 48-50.

① National Electric Code (240-11)
"A current limiting overcurrent protective device, which, when interrupting currents in its current limiting range, will reduce the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit, if the device were replaced with a solid conductor having comparable impedance."

② Underwriters Laboratories (UL 489, Par. 2.5)
"A circuit breaker that does not employ a fusible element and that when operating within its current limiting range, limits the let-through I^2t to a value less than the I^2t of a ½ cycle wave of the symmetrical prospective current."



Molded Case Switch

A molded case switch is available in the ED2, ED4, ED6, HHED6, CED6 type circuit breakers. This device employs the same operating mechanism as the thermal magnetic and magnetic only units. A preset instantaneous function is factory installed to allow the switch to trip at a value over 1000A and protect itself against high fault conditions. No overload or low fault current protection is provided. This protection must be supplied by separate overcurrent devices. Catalog information is located on pages 48-51.

Interrupting Ratings—Symmetrical RMS Amperes (kA) Based on UL 489 Standards, UL File #E10848

Breaker Type	RMS Symmetrical Amperes (kA) UL A.I.R.							
	AC					DC		
	120	240	277	480	600	125	250	500①
ED2 (1-P)	10	–	–	–	–	10	–	–
ED2 (2,3-P)	–	10	–	–	–	–	5 (2-P)	–
ED4 (1-P)	65	–	22	–	–	5	–	–
ED4 (2,3-P)	–	65	–	18	–	–	30 (2-P)	–
ED6 (2,3-P)	–	65	–	25	18	–	30 (2-P)	18 (3-P)
HED4 (1-P) (15-30 Amps)	100	–	65	–	–	10	–	–
HED4 (1-P) (35-110 Amps)	100	–	25	–	–	10	–	–
HED4 (2,3-P)	–	100	–	42	–	–	30 (2-P)	–
HED6 (2,3-P)	–	100	–	30	18	–	30 (2-P)	25 (3-P)
HHED6 (2,3-P)	–	100	–	65	25	–	–	–
CED6 (2,3-P)	–	200	–	200	100	–	30 (2-P)	50 (3-P)

① For 500VDC applications the customer's power supply and load must be wired as shown in Figure 1 on page 4.

Breaker Type	RMS Symmetrical Amperes (kA) IEC A.I.R. (157-P1) Volts AC (50/60 Hz)		
	220/240	380/415	500
ED4 (3-P)	65	18	NA
HED4 (3-P)	100	42	NA
HED6 (3-P)	100	30	NA
CED6 (3-P)	200	200	NA

Breaker Type	IEC A.I.R. (947-2)					
	(Icu)	(Ics)	(Icu)	(Ics)	(Icu)	(Ics)
ED6 (3-P)	65	17	35	9	18	5

Instantaneous Trip

ETI motor circuit interrupters, types ED6-ETI, CED6-ETI (adjustable instantaneous magnetic trip only) are designed for use in welding circuits, motor circuits and combination starters where short circuit protection only is required. When used in combination starters, they serve in conjunction with motor protective relays to offer the best available protection. The relays guard against motor overloads and the circuit breaker provides short circuit protection. Catalog information is located on page 50.

Instantaneous Trip Adjustments

Motor Full Load Amperes	ETI Trip Setting①		Breaker Ampere Rating
	Adjustment	Amperes	
.20 - .33	Low	2.6	1
.34 - .45	2	4.5	
.46 - .56	3	6	
.57 - .68	4	7.5	
.69 - .81	High	9	
.53 - .83	Low	7	2
.84 - 1.14	2	11	
1.15 - 1.45	3	15	
1.46 - 1.68	4	19	
1.69 - 2.00	High	22	
.76 - 1.29	Low	10	3
1.30 - 1.75	2	17	
1.76 - 2.29	3	23	
2.30 - 2.68	4	30	
2.69 - 3.18	High	35	
1.23 - 1.99	Low	16	5
2.00 - 2.75	2	26	
2.76 - 3.52	3	36	
3.53 - 4.14	4	46	
4.15 - 4.90	High	54	
2.30 - 3.83	Low	30	10
3.84 - 5.37	2	50	
5.38 - 6.52	3	70	
6.53 - 7.68	4	85	
7.69 - 9.10	High	100	
4.23 - 6.91	Low	55	25
6.92 - 9.61	2	90	
9.62 - 11.91	3	125	
11.92 - 13.83	4	155	
13.84 - 16.40	High	180	
6.15 - 10.37	Low	80	30
10.38 - 14.22	2	135	
14.23 - 18.06	3	185	
18.07 - 20.75	4	235	
20.76 - 24.50	High	270	
8.84 - 14.22	Low	115	40
14.23 - 19.60	2	185	
19.61 - 24.99	3	255	
25.00 - 28.83	4	325	
28.84 - 34.00	High	375	
13.84 - 23.06	Low	180	50
23.07 - 31.52	2	300	
31.53 - 39.99	3	410	
40.00 - 46.14	4	520	
46.15 - 54.50	High	600	
24.23 - 41.52	Low	315	100
41.53 - 56.91	2	540	
56.92 - 68.45	3	740	
68.46 - 76.91	4	890	
76.92 - 90.90	High	1000	
38.46 - 55.37	Low	500	125
55.38 - 70.75	2	720	
70.76 - 84.60	3	920	
84.61 - 96.14	4	1100	
96.15 - 113.60	High	1250	

① All values calibrated within guidelines of UL 489.

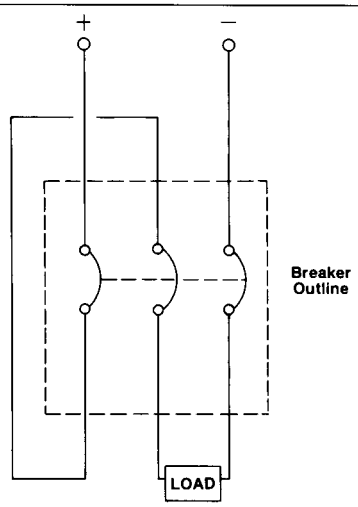
Circuit Breaker Operation

With the mechanism latched and the contacts open, the operating handle will be in the OFF position. Moving the handle to the ON position closes the contacts and establishes a circuit through the breaker. Under overload or short circuit conditions sufficient to automatically trip or open the breaker, the operating handle moves to a position between ON and OFF. To relatch the circuit breaker after automatic operation, move the operating handle to the extreme OFF position. The circuit breaker is now ready for reclosing.

The overcenter toggle mechanism is trip free of the operating handle. The circuit breaker, therefore, cannot be held closed by means of the handle should a tripping condition exist. After automatic operation, the handle assumes an intermediate position between ON and OFF, thus displaying a clear indication of tripping.

Maintenance

Experience has shown that properly applied molded case circuit breakers normally do not require maintenance. However, some industrial users may choose to establish an inspection and maintenance procedure to be carried out on a regular basis. For detailed information, consult applicable NEMA publications or your local Siemens sales office.

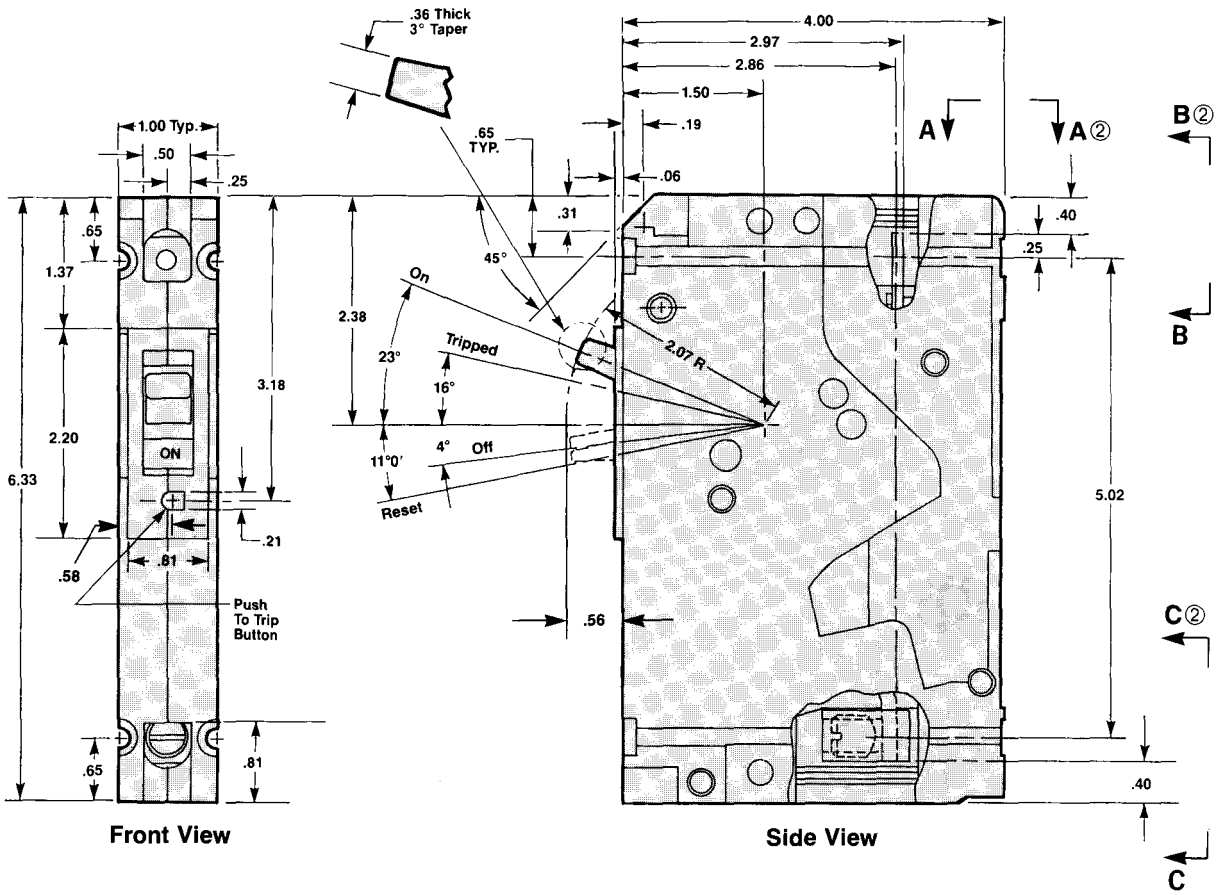


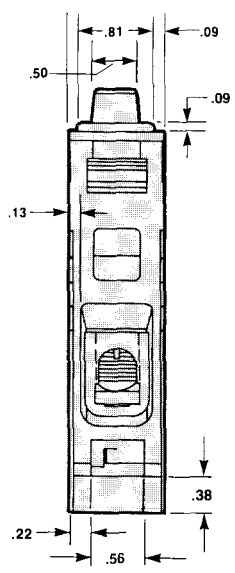
Wiring Diagram for 500V dc 3-Pole—Ungrounded Systems Only

Figure 1

I-T-E ED-Frame Outline Drawings①—1-Pole

Types ED2, ED4, HED4,





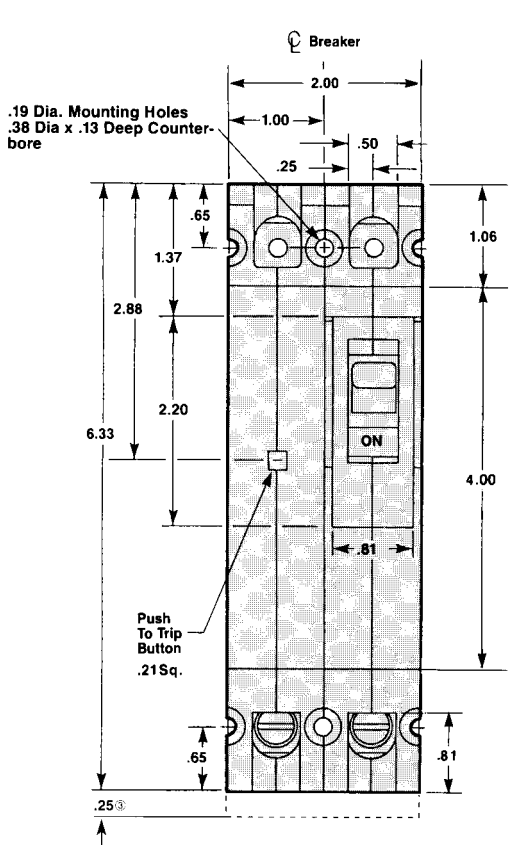
Handle Operating Forces

Operation	lb.
OFF to ON	4
ON to OFF	2
TRIPPED to RESET	6

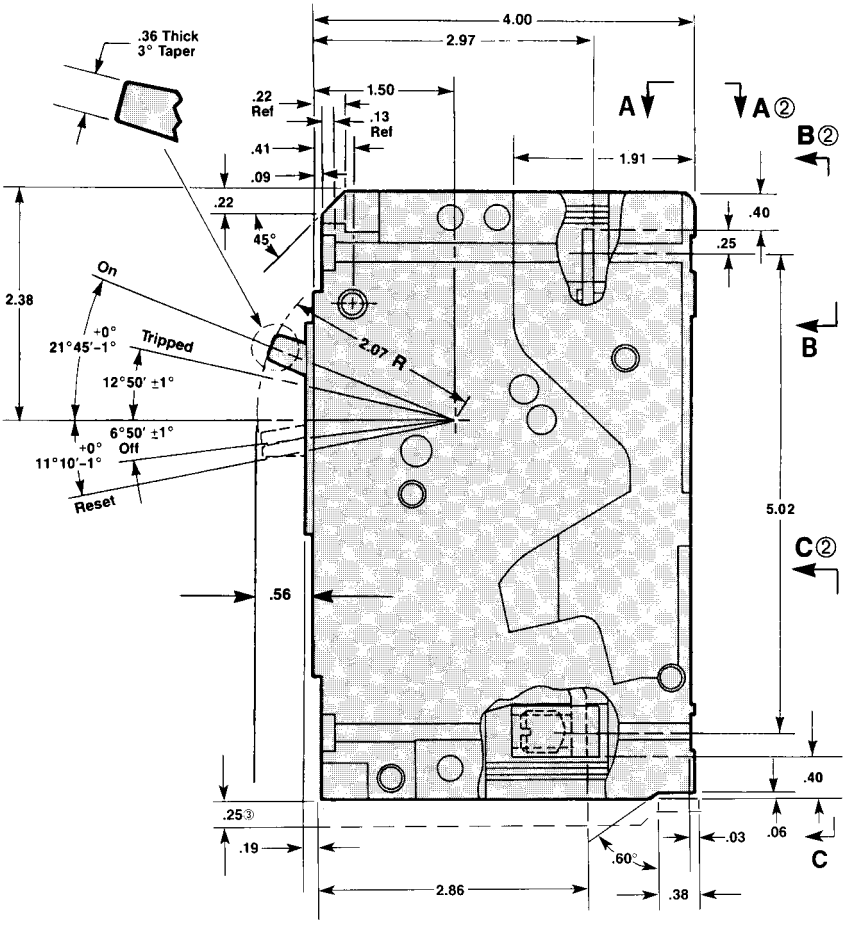
①All drawing dimensions are shown in inches.
②See detail drawings on page 9.

I-T-E ED-Frame Outline Drawings①—2-Pole

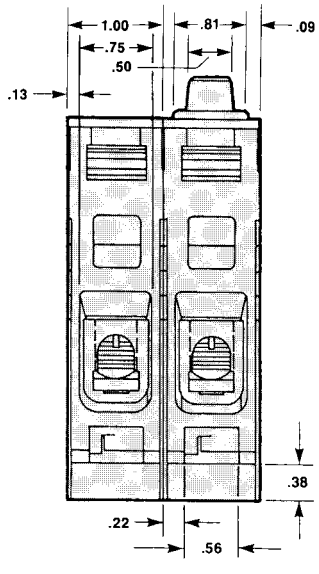
Types ED2, ED4, ED6, HED4, HED6, HHED6



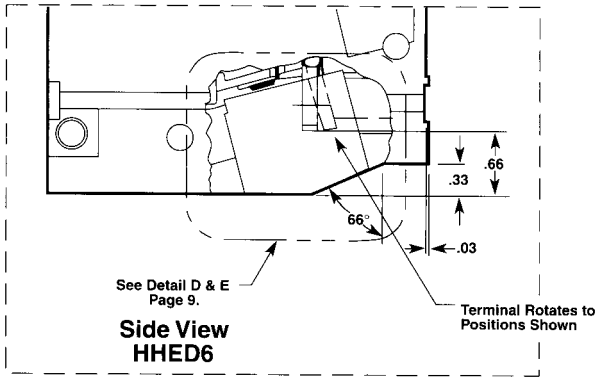
Front View



Side View



End View



Side View HHED6

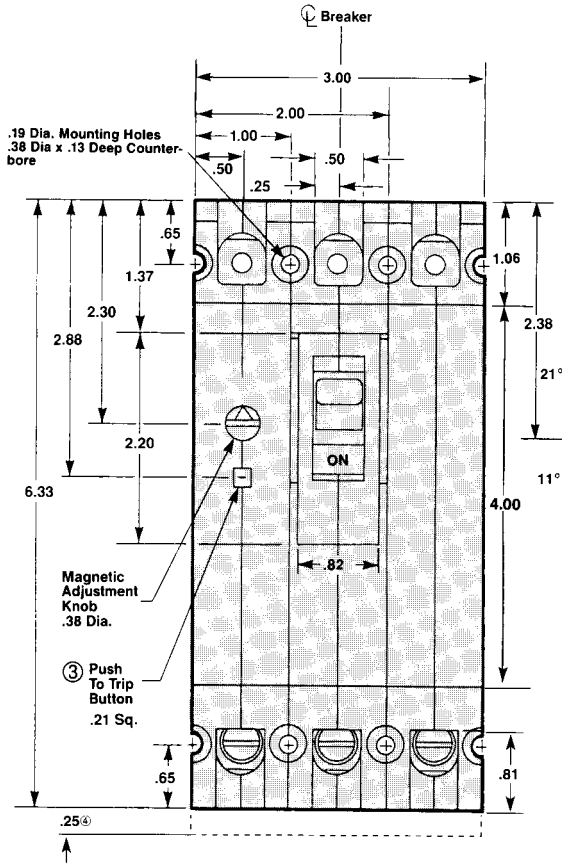
Handle Operating Forces

Operation	lb.
OFF to ON	8-10
ON to OFF	8-10
TRIPPED to RESET	14

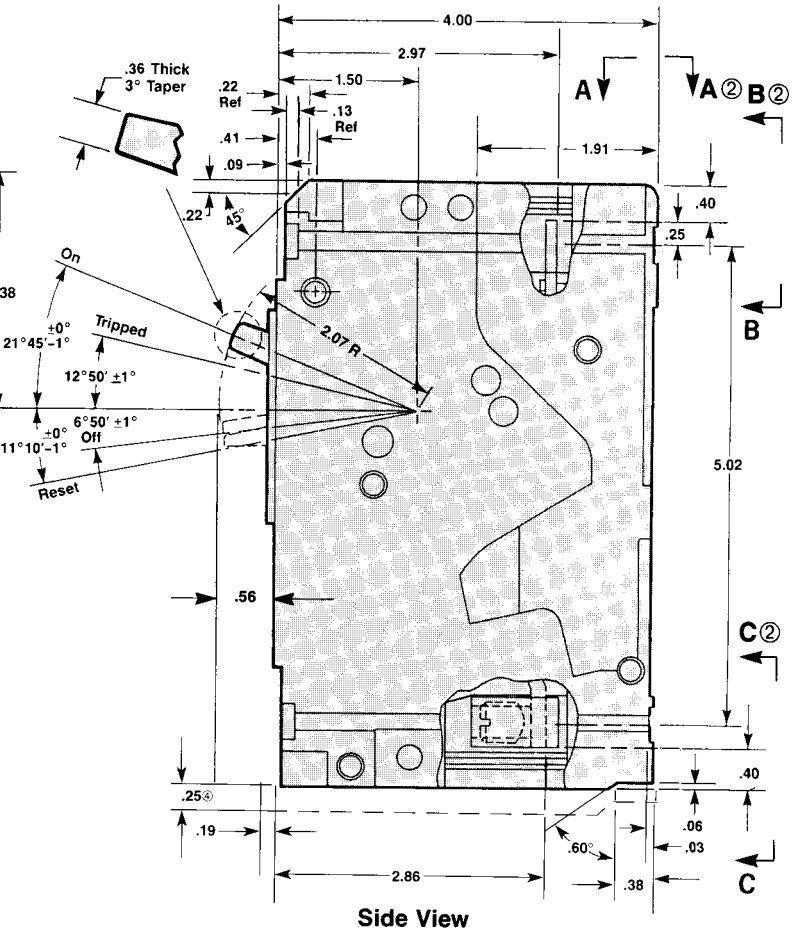
① All drawing dimensions are shown in inches.
② See detail drawings on page 9.
③ HHED6 is .25 in. longer.

I-T-E ED-Frame Outline Drawings①—3-Pole

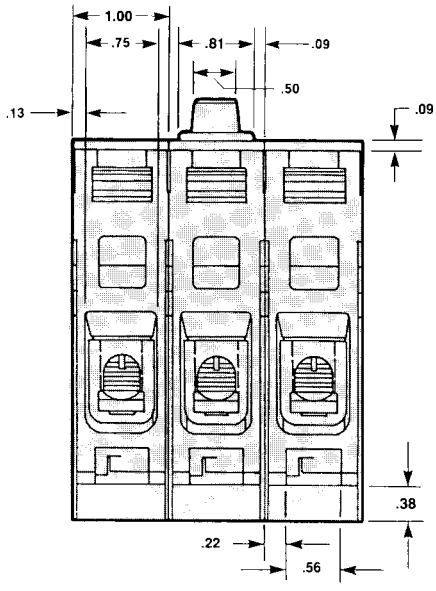
Types ED2, ED4, ED6, HED4, HED6, HHED6, ED6-ETI



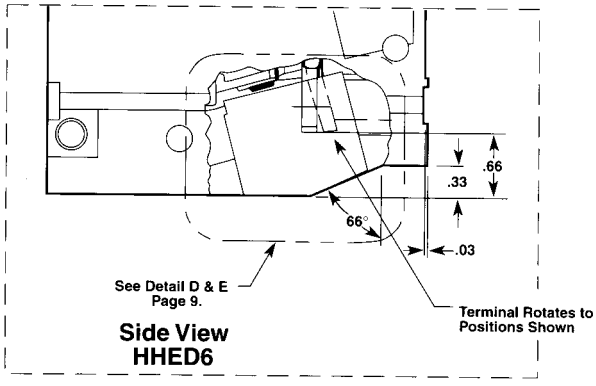
Front View



Side View



End View



Side View HHED6

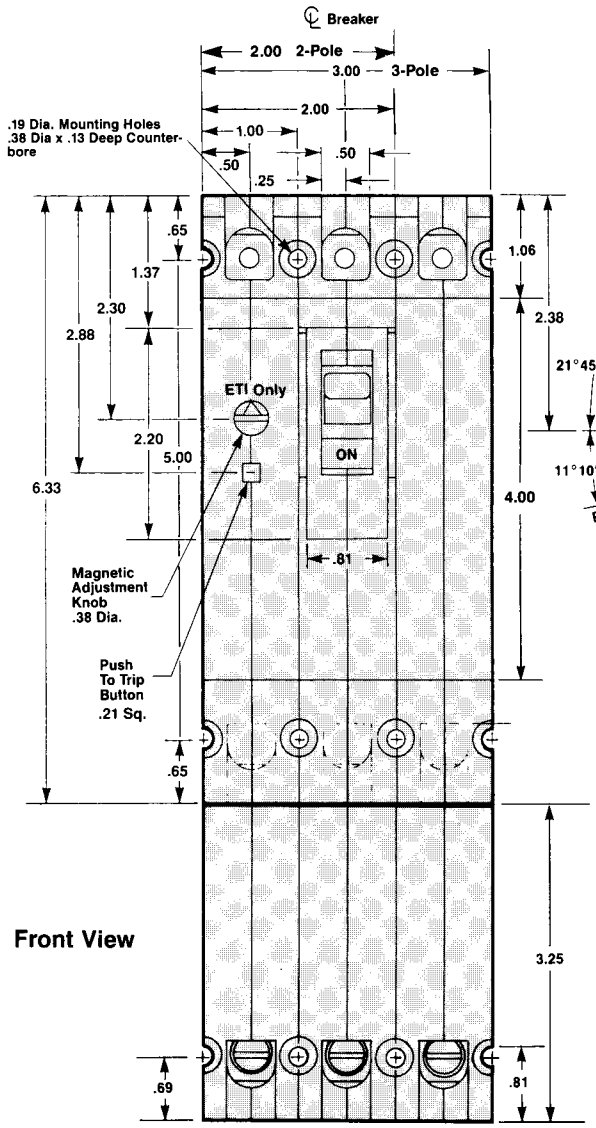
Handle Operating Forces

Operation	lb.
OFF to ON	8-10
ON to OFF	8-10
TRIPPED to RESET	14

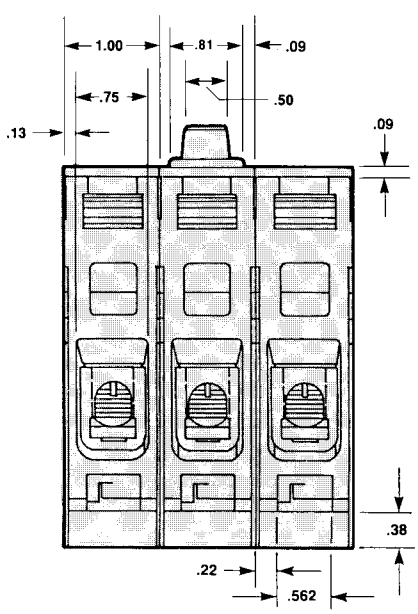
① All drawing dimensions are shown in inches.
② See detail drawings on page 9.
③ Switch does not have push to trip button.
④ HHED6 is .25 in. longer.

I-T-E ED-Frame Outline Drawings①—2 and 3-Pole

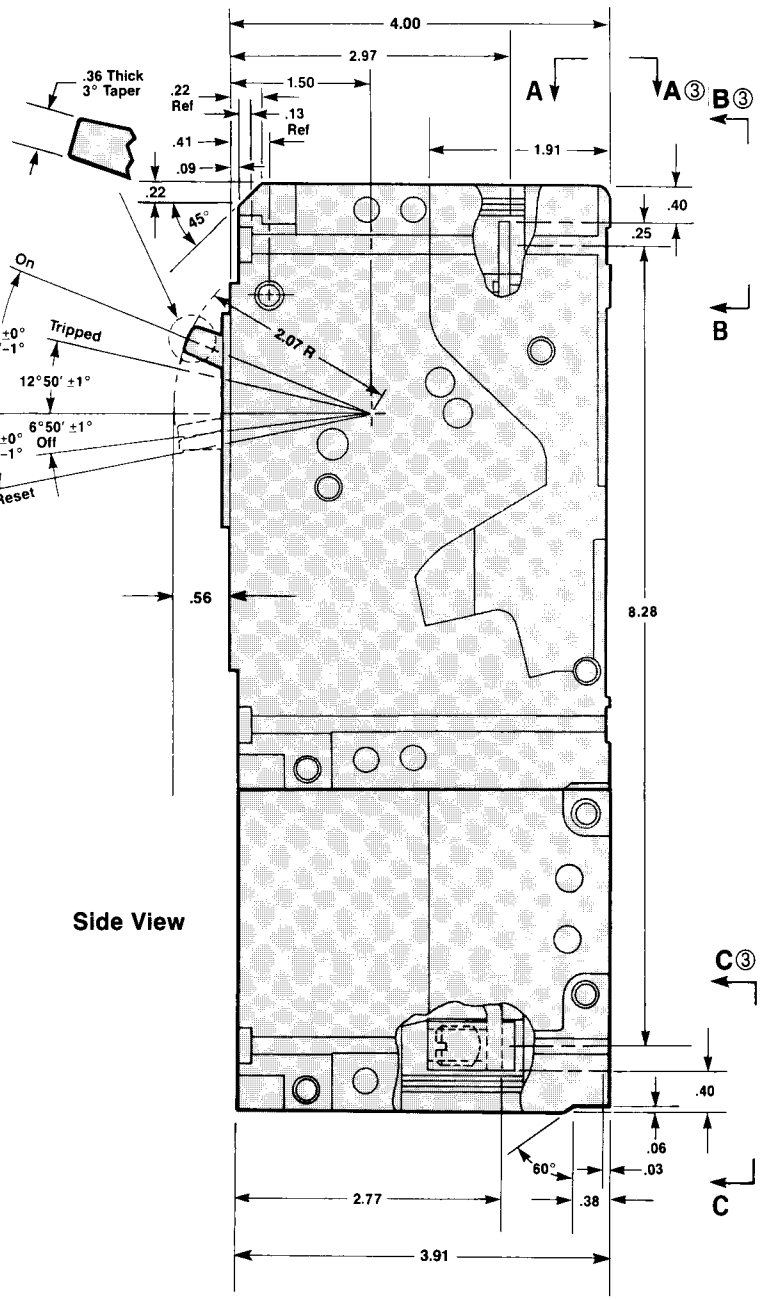
Types CED6, CED6-ETI②



Front View



End View



Side View

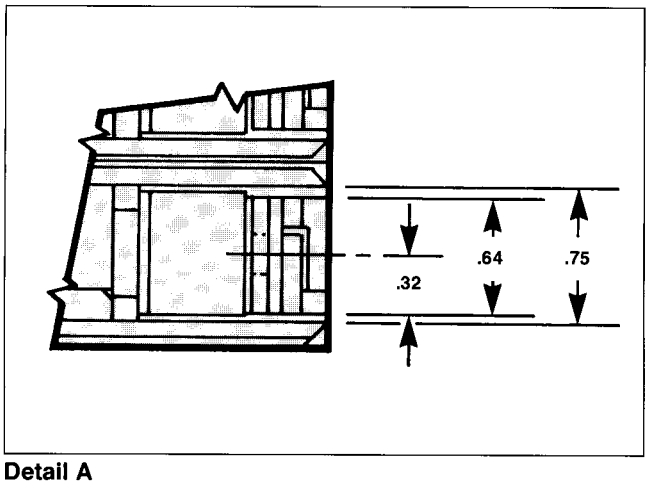
Handle Operating Forces

Operation	lb.
OFF to ON	8-10
ON to OFF	8-10
TRIPPED to RESET	14

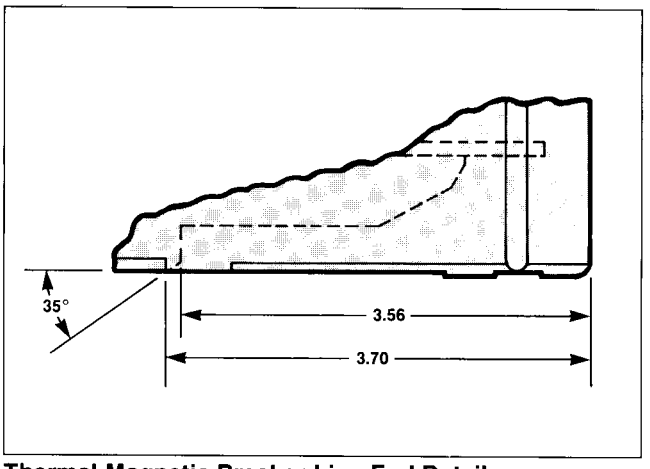
①All drawing dimensions are shown in inches.
②Only available as 3-pole breaker.
③See detail drawings on page 9.

I-T-E ED-Frame Detail Drawings①—1, 2 and 3-Pole

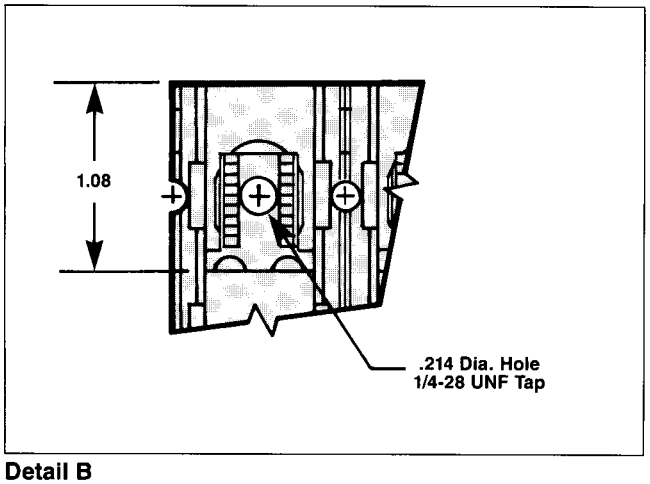
Types ED2, ED4, ED6, HED4, HED6, HHED6, CED6, ED6-ETI, CED6-ETI



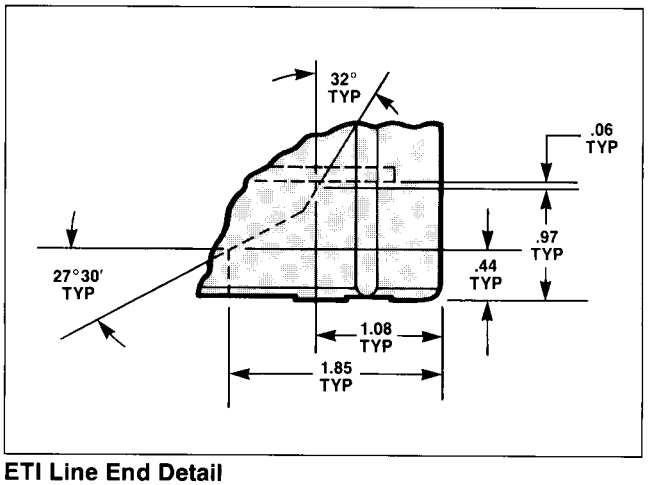
Detail A



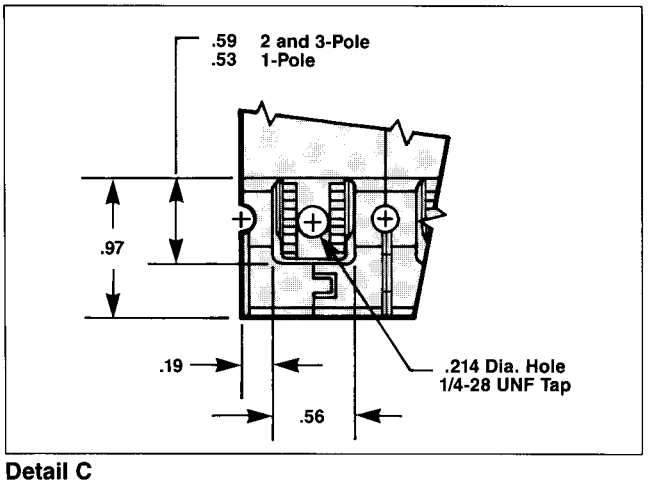
Thermal-Magnetic Breaker Line End Detail



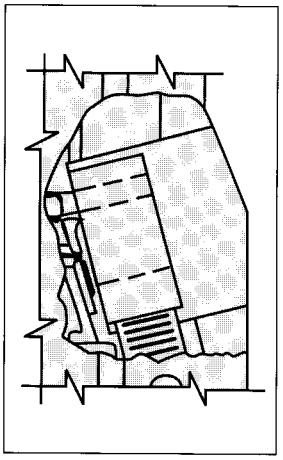
Detail B



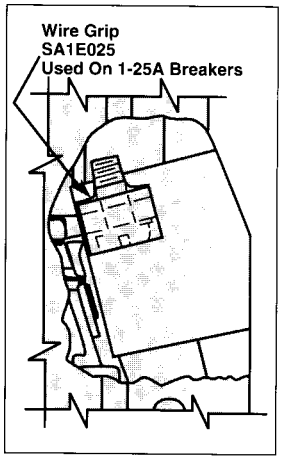
ETI Line End Detail



Detail C



Detail D



Detail E

①All drawing dimensions are shown in inches.

I-T-E Pressure Wire Connectors

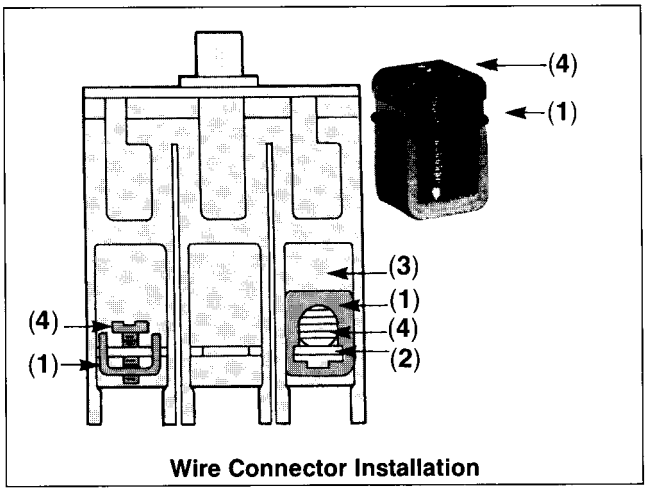
⚠ DANGER

Hazardous Voltage. Will cause death or severe injury.

Turn power off supplying switchboard or panel before installing.

⚠ SAFETY INSTRUCTIONS

A. Place terminal connector body (**1**) onto breaker tab (**2**) in terminal cavity (**3**) (Figure 1).
B. Insert cable into connector body between breaker tab and cable set screw, except SA1E025—place cable between breaker tab and connector body.
C. Hold in place while tightening set screw (**4**) with a screwdriver or hex wrench on TA1E6125. See Table for proper wire size selection and screw tightening torque.



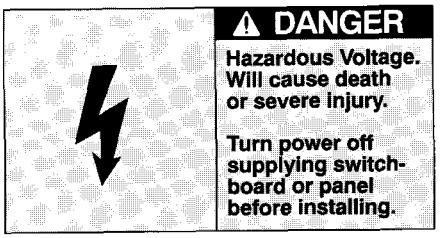
Wire Connector Installation

Figure 1

Wire Connectors and Tightening Torque

Connector Catalog Number	UL Connector Wire Range	Cable Wire Size	Cable Set Screw Tightening Torque In./Lb.	ED-Frame Breaker Type
SA1E025	(1 piece) #14-10 AWG (Cu) #12-10 AWG (Al)	#14-10 AWG	32	15-25A 1, 2 & 3-Pole Line & Load Side
LN1E100	(1 piece) #10-#2 AWG (Cu/Al)	#10 AWG #8 AWG #6-4 AWG #3 AWG #2-1/0 AWG	20 36 45 50 60	30-100A 1-Pole Line Side Only 2 or 3-Pole Line & Load Side All CED6 LIne Side Only
LD1E060	(1 piece) #10 Cu #8-4 Cu/Al	#10 AWG #8 AWG #6-4 AWG	20 36 45	30-60A 1-Pole Load Side Only CED6 Load Side Only
LD1E100	(1 piece) #4 Cu #3-1/0 Cu/Al	#4 AWG #3-1/0 AWG #2-1/0AWG	45 50 60	70-100A 1-Pole Load Side Only CED6 Load Side Only
TA1E6125	(1 piece) #3-3/0 Cu #1-2/0 Al	#3-3/0 AWG	80	110-125A 2 or 3-Pole Line & Load Side
TC1ED6150	(1 piece) #10-1/0 Cu	#10-1/0 Cu	100	30-125A 2 or 3-Pole Line & Load Side

I-T-E Compression Connector (CCE125)


⚠ DANGER
Hazardous Voltage. Will cause death or severe injury.
Turn power off supplying switchboard or panel before installing.

⚠ SAFETY INSTRUCTIONS

General

NOTE: This instruction sheet outlines the recommended installation procedure. Use of these lugs in some installations may result in less wire bending space than is specified in the National Electric Code.

Installation of Compression Connector

A. Turn off power supplying device before installation compression lugs.

B. Remove any existing wire connectors from circuit breaker.

C. Install circuit breaker.

D. Preform cables to final configuration and strip insulation back $^{13}/_{16}$ in. on each conductor. Use an appropriate insulation stripping tool to avoid damaging the conductor. (See Figure 1.)

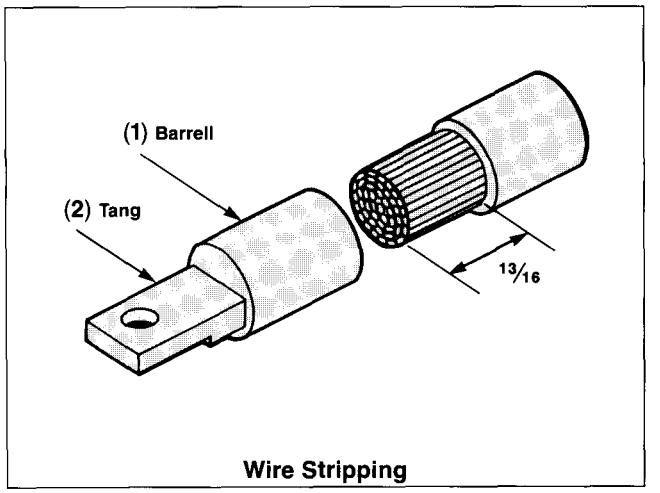


Figure 1

E. Clean aluminum conductor surfaces throughly with a wire brush or other suitable means, to remove oxides and other contaminants from the conductor.

NOTE: Copper wires and the compression connector should **not** be cleaned abrasively.

F. Remove cap from compression connector and insert cable fully into barrel (**1**) (Figure 1) of connector.

G. Insure that connector tang(s) (**2**) (Figure 1) are in their proper orientation prior to crimping. This helps avoid twisting of cables during installation.

H. Select an appropriate tool and die combination from Table 1 and make the required number of crimps within the boundaries stamped on the connector barrel. Refer to Figure 2 for sequence of multiple crimps.

Table 1—Compression Tool and Die Chart For Copper and Aluminum Conductors

Wire Size	Tool Mfgr.	Tool No.	Die No.	No. of Crimps
2/0	Homac	UT-5 UT-15	TW TY 58/60	2 2
2/0	Burndy	Y 35	58/60	2
2/0	T & B	TBN-6 TBN-15	TW TY 58/60	2 2
#14-2/0	Square D	VC-6	—	1

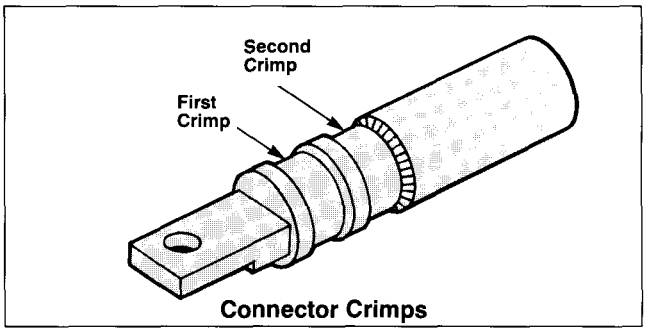


Figure 2

I. Remove any inhibitor compound expelled during the crimping operation from the connector body and the cable insulation.

J. Slip insulating cover over connector tang and then over connector barrel so that only the connector tang is exposed (Figure 3).

Warning: Short spacings will result if Step J is not followed.

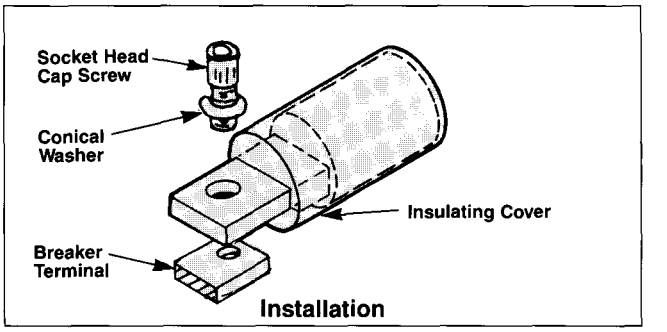


Figure 3

K. Position connector tang on top of the circuit breaker terminal pad and secure with ¼-28 x ½ in. socket head cap screw and conical spring washer. Conical spring washer is to be installed with convex side of washer toward underside of screw head (Figure 3). Torque screw to 50 in-lb.

I-T-E Handle Locking Devices

ATTACHING I-T-E HANDLE BLOCKING DEVICE (E2HBL)

To Block Handle ON

Turn breaker ON. Assemble blocking device to breaker by positioning it below handle (Figure 1). Insert tabs (**1**) into slots (**2**) on either side of pad.

To Block Handle OFF

Turn breaker OFF. Assemble blocking device to breaker by positioning it above handle (Figure 1). Insert tabs (**1**) into slots (**2**) on either side of pad (Figure 2).

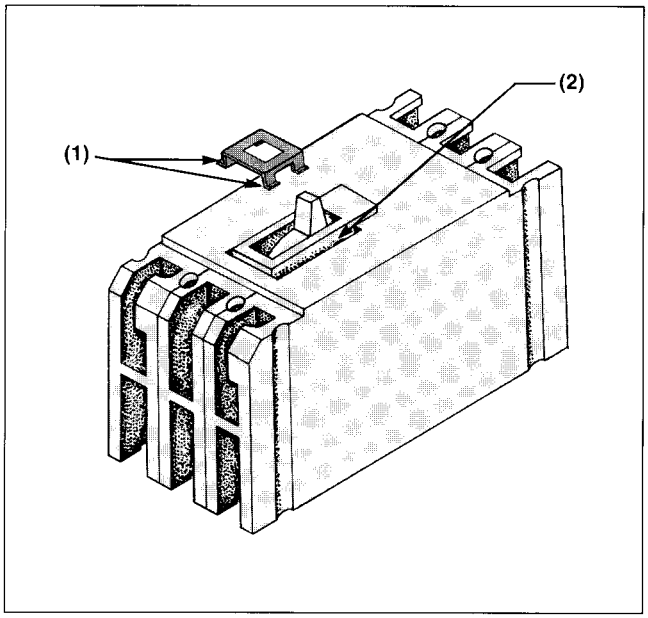


Figure 1

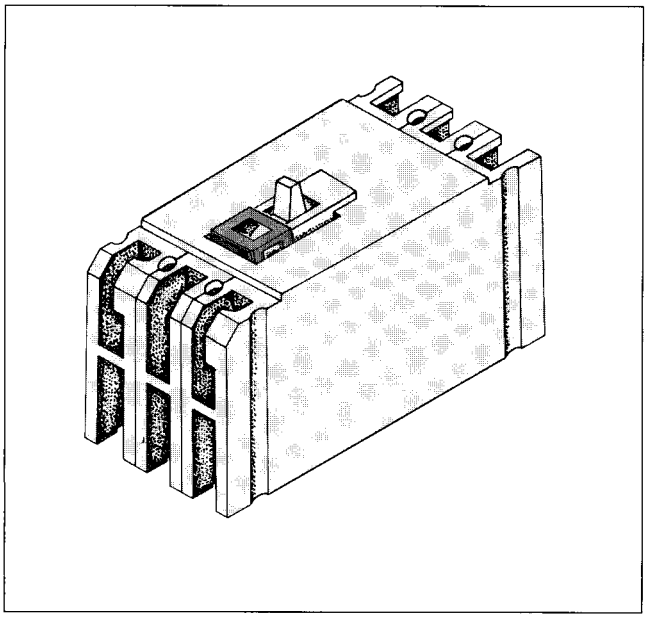


Figure 2

ATTACHING I-T-E PADLOCKING DEVICE (ED2HPL)

Assemble padlocking device to breaker by placing it over breaker handle (Figure 3). Position tabs (**1**) into slots (**2**) on either side of pad (Figure 4); tighten screws (**3**) to secure padlocking device.

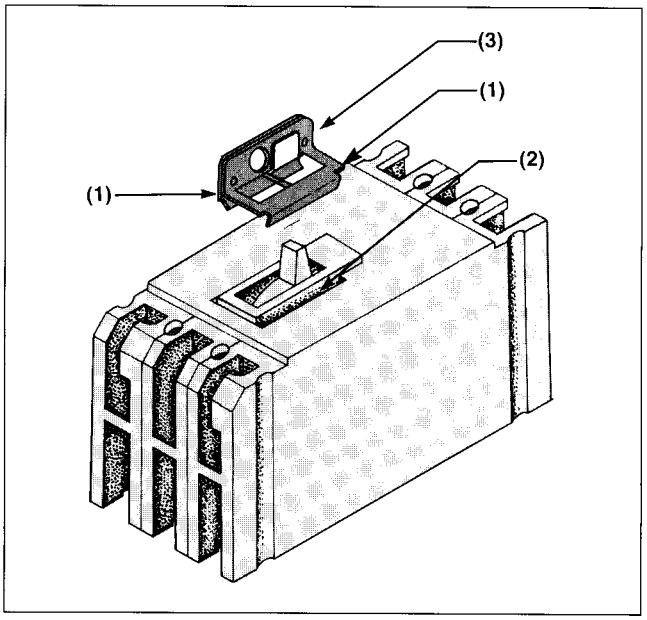


Figure 3

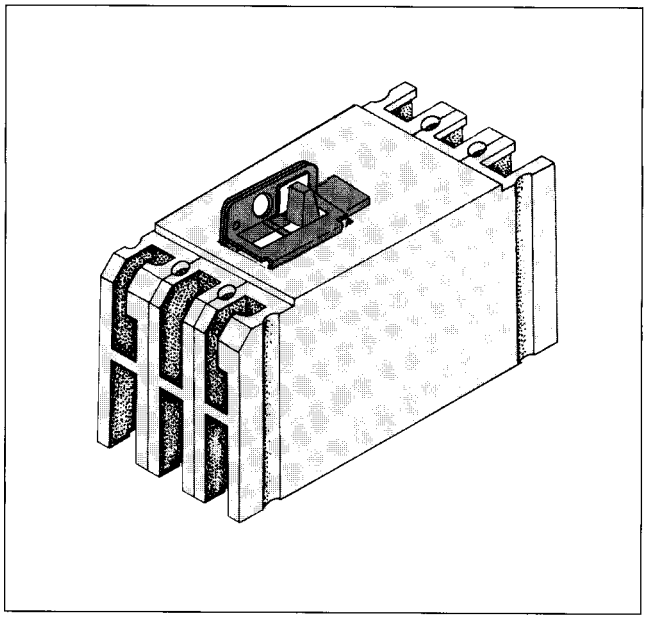
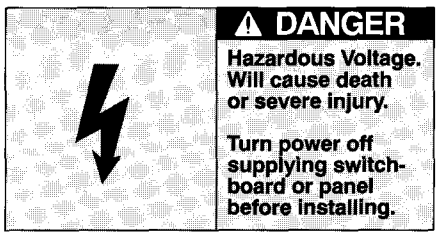


Figure 4

I-T-E Rear Connecting Studs



SAFETY INSTRUCTIONS

Mounting Preparation and Assembly

A. Remove wire terminals from breaker.

B. Select proper rear connecting stud assembly as required for line terminals (Figure 3) and load terminals (Figure 1).

C. Align rear connecting studs with breaker terminals and secure to breaker terminals with #12-24 screws, lock-washers and flat washers.

D. Install line shields on line side of breaker (Figure 3).

E. Install two #3/8-16 silver finished brass nuts on the threaded end of each rear connecting stud.

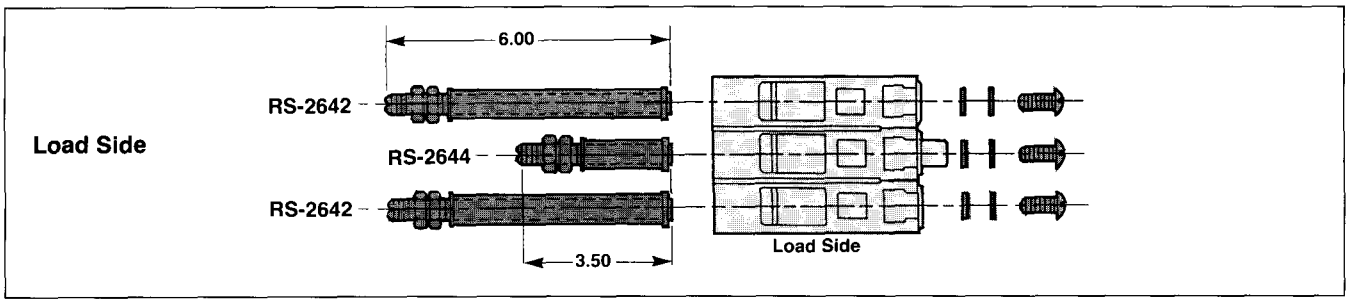
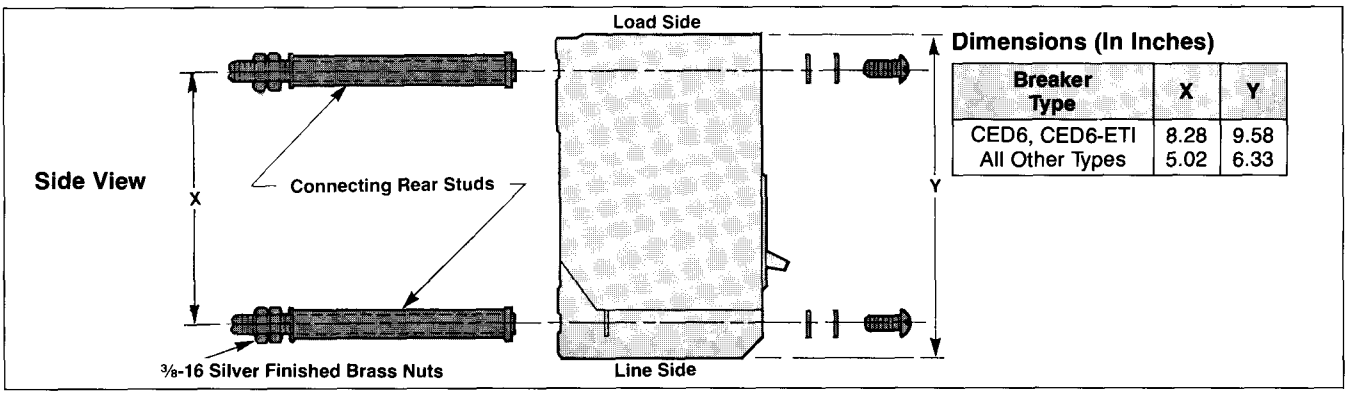


Figure 1



Dimensions (In Inches)

Breaker Type	X	Y
CED6, CED6-ETI	8.28	9.58
All Other Types	5.02	6.33

Figure 2

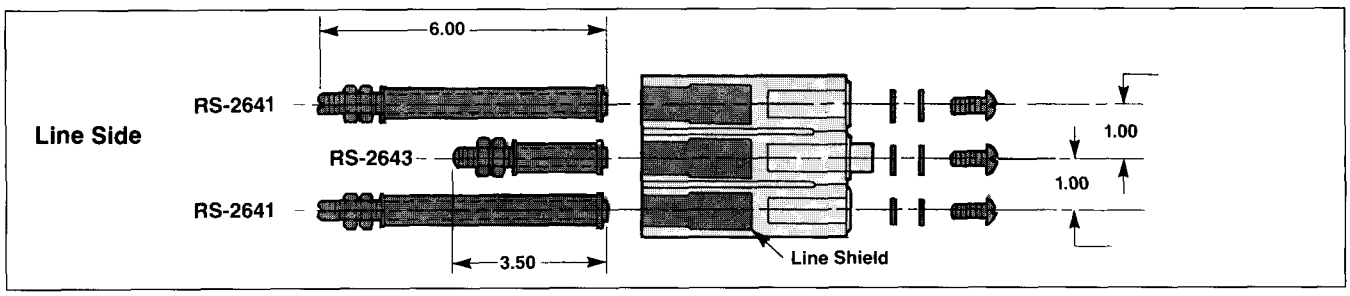


Figure 3

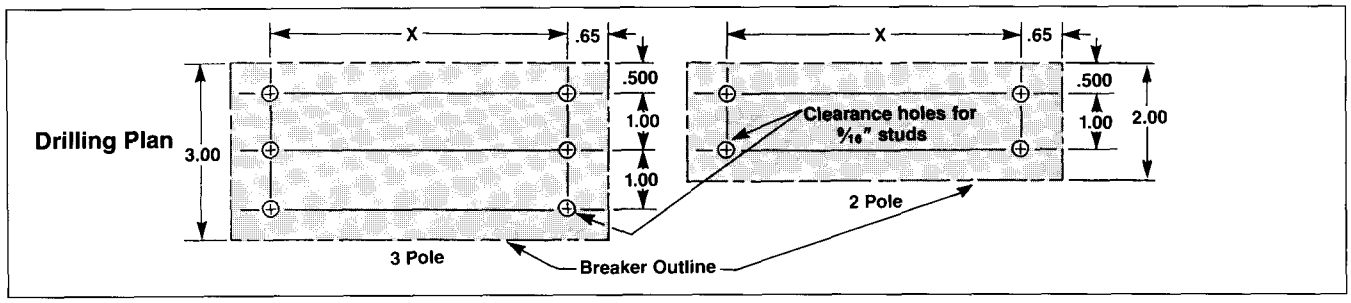
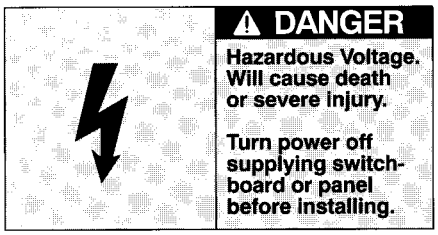


Figure 4

I-T-E Plug-In Adapters



SAFETY INSTRUCTIONS

General

A complete plug-in installation requires one line end adapter assembly (consisting of a mounting block, tulip connectors and associated hardware), one load end adapter assembly and one switchboard mounting plate. The switchboard mounting plate is optional and can be replaced by other mounting means to suit customer's requirements.

Application Information

Breaker Type	No. of Poles	Line End Adapter Cat. No.	Load End Adapter Cat. No.	Switch-board Mtg. Plate Cat. No.
CED6, CED6-ETI	2 3	PC2637 PC2657	PC2638 PC2658	PL2617 PL2617
All Other Types	2 3	PC2637 PC2657	PC2638 PC2658	PL2616 PL2616

Mounting Preparation (Figures 1 and 2)

A. If the switchboard mounting plate (**1**) is to be used, provide drilling as shown in Figure 1.

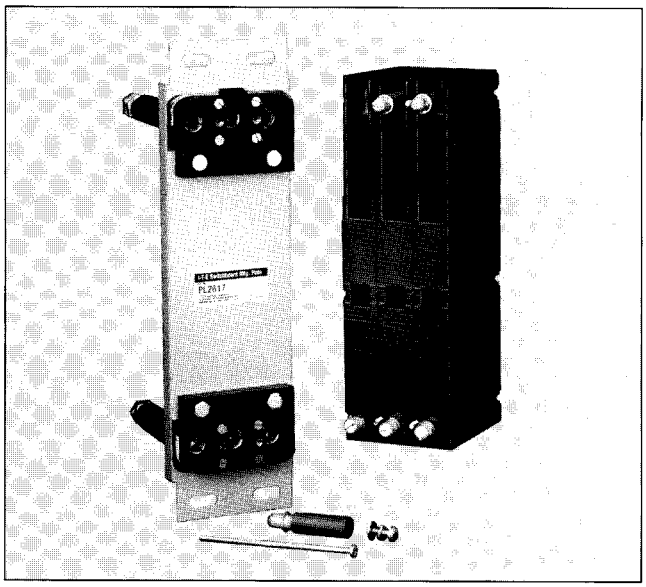
B. If other mounting means are to be used, provide the cutouts and drilling required to mount the adapter blocks as shown in Figure 2.

Switchboard Mounting Plate, if used (Figure 3)

A. Place switchboard mounting plate (**1**) in position at location previously prepared in Step A above. Secure in place with 1/4 in. hardware (furnished by customer).

Mounting Block (Figure 3)

A. Align mounting block (**2**) with cutouts in switchboard mounting plate (or customer's mounting means as previously prepared in Step B above) and secure in place with 1/4 in. screws (**3**), washers (**4**) and (**5**) and hexnuts (**6**) furnished.



Breaker Preparation (Figure 4)

A. Remove pressure wire connectors from breaker if present. Select line side breaker stud and insulator (**11**) and (**12**), assemble to terminals from back of breaker and secure to breaker terminals with #12-24 screws and washers (**7**), (**8**), (**9**) as shown in Figure 4. Recommended tightening torque for these screws is 2½-3 ft. lb. to assure a good electrical connection. Repeat this procedure for the remaining line and load connections, breaker studs and insulations.

B. Insert line end shields (**10**) into slots provided at line end of breaker.

C. Affix accessory warning labels (**13**), (**14**) to top of breaker as indicated in Figure 5.

Final Assembly (Figure 6)

A. Make bus and/or cable connection to rear of mounting block studs using hex nuts (**15**) furnished to secure this connection.

Caution: Make certain that breaker operating handle is in the OFF position before proceeding with the next step.

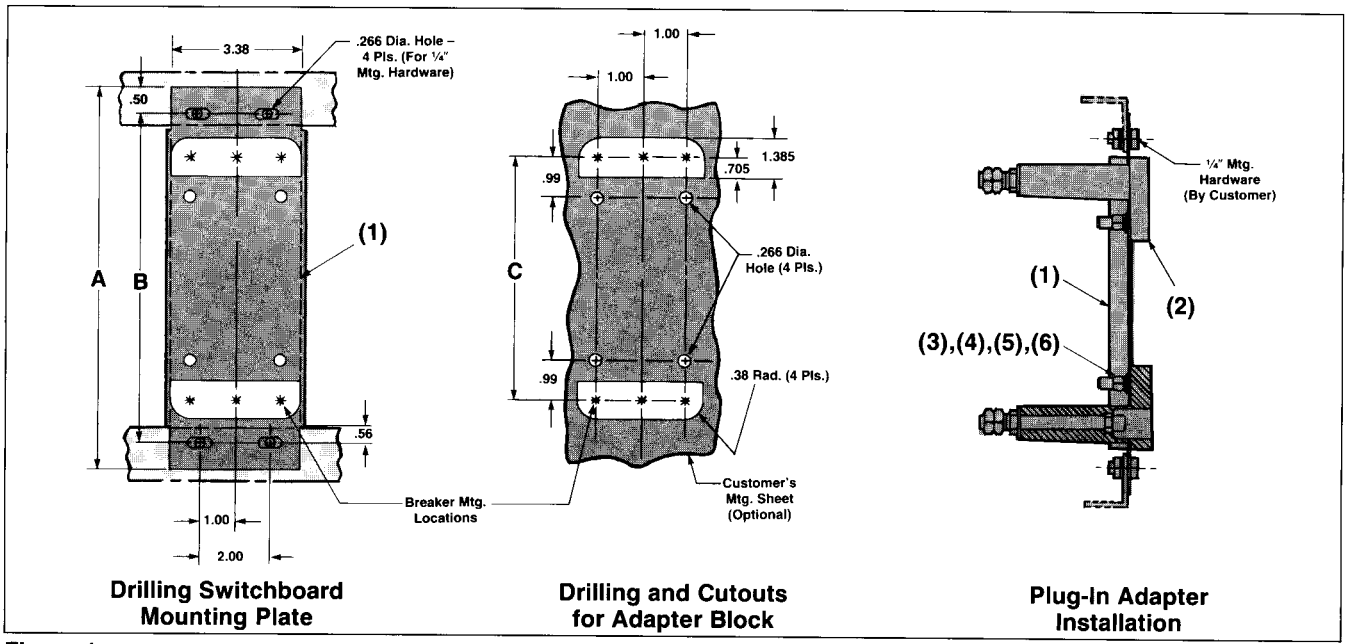
B. Align breaker with mounting blocks and force female tulip clips over male studs (**11**) in mounting blocks until breaker base bottoms against mounting block. Secure breaker in place with #8-32 x 4.06 in. mounting screws (**16**).

C. If installation requires use of front panel trim, provide cutout for breaker escutcheon (Figure 7).

Installation Diagrams

Dimensions (In Inches)

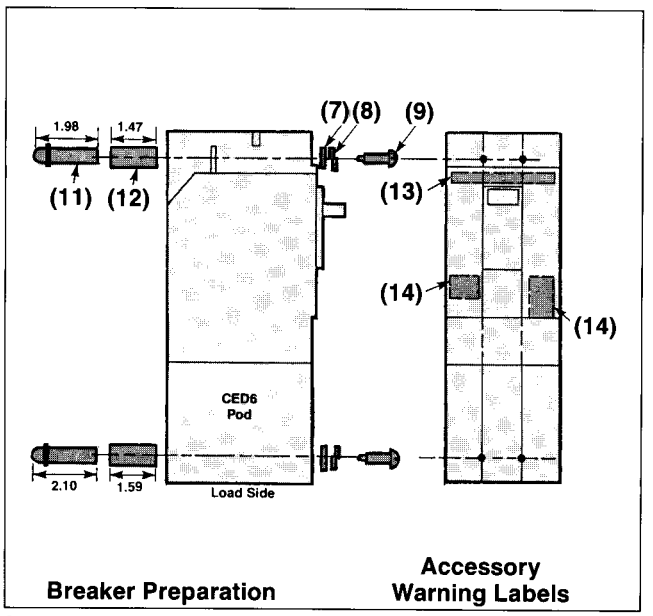
Breaker Type	A	B	C
CED6, CED6-ETI	12.25	11.25	8.28
All Other Types	9.00	8.00	5.02



Drilling Switchboard Mounting Plate — Figure 1

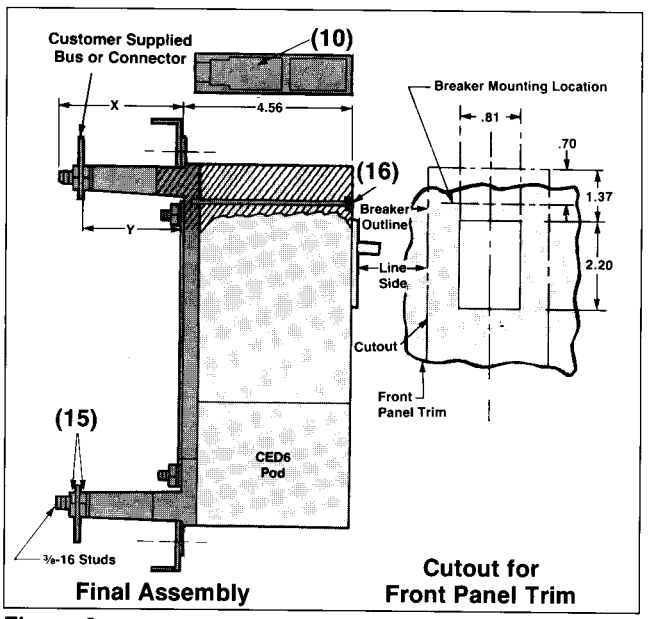
Drilling and Cutouts for Adapter Block — Figure 2

Plug-In Adapter Installation — Figure 3



Breaker Preparation — Figure 4

Accessory Warning Labels — Figure 5



Final Assembly — Figure 6

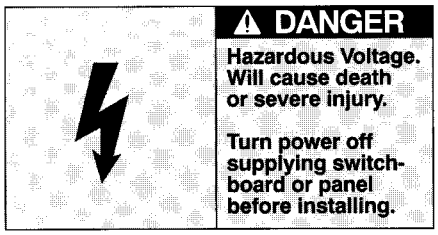
Cutout for Front Panel Trim — Figure 7

Dimensions (In Inches)

Pole	X	Y
Center	2.28	1.50
Left/Right	4.50	3.62

I-T-E Shunt Trip, Undervoltage Trip, Auxiliary Switch and Bell Alarm Switch Accessories

Installation



SAFETY INSTRUCTIONS

For this publication, the term circuit breaker also includes molded case switches and motor circuit interrupters.

Circuit Breaker Preparation
(A thru D for 1-pole circuit breakers; D for 2 and 3-pole circuit breakers.)

A. For circuit breakers requiring knockouts, align accessory to circuit breaker as shown in Figure 1. Mark only the breaker knock-outs which correspond to the actuator blades protruding from the accessory package.

B. Place the circuit breaker on a flat surface with the marked knock-outs facing you as shown in Figure 2.

C. Using a sharp object such as a knife blade point, place point in groove of knock-out and tap on handle until groove is pierced. Move around the groove until the knock-out can be removed. NOTE: It is important that the slotted pin is completely exposed and that all plastic has been trimmed and removed until the edge of the knock-out has been cleaned and the metal pin has been exposed. The circuit breaker is ready for mounting the accessory unit.

Caution: Do not use excessive force or the internal mechanism of the circuit breaker may be damaged.

D. Before assembling accessory unit to the breaker, make certain that all exposed accessory actuator slots are in line with the locating tabs (**1**) *and the circuit breaker handle* (**2**) *is in the tripped position* (Figure 1).

Accessory Mounting Instructions

Caution: Turn off and lock out all power before removing circuit breaker for modification. Breaker must be completely disconnected and removed from any electrical equipment before accessory is attached.
Never attempt to add more than one accessory module to the circuit breaker. Combinations must be ordered within a single module.

A. Position accessory unit (**3**) against the side of the circuit breaker (**4**) carefully to determine that all accessory actuator blades are engaged into the actuator slots of the circuit breaker (**5**). NOTE: Fiber washer (**6**) must be placed between the circuit breaker and the accessory unit as shown in Figure 1.

B. Secure accessory unit to the circuit breaker using two #6-20 x 1.38 in. thread cutting screws and split lockwashers (**7**).

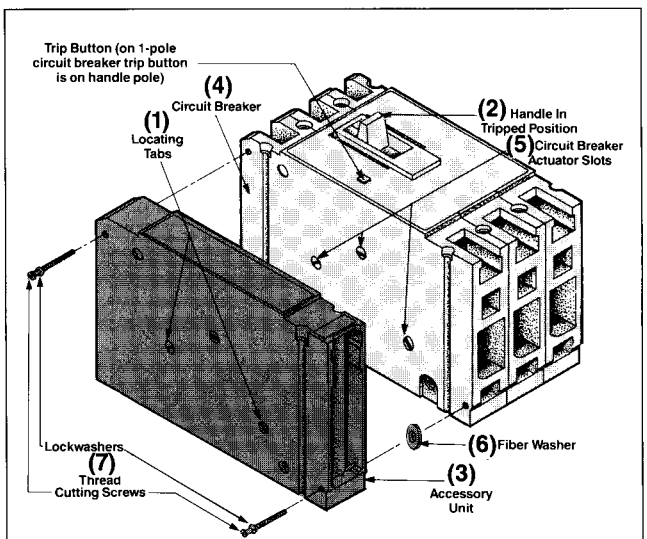

Trip Button (on 1-pole circuit breaker trip button is on handle pole)
(4) Circuit Breaker
(1) Locating Tabs
(2) Handle In Tripped Position
(5) Circuit Breaker Actuator Slots
Lockwashers (7)
Thread Cutting Screws
(6) Fiber Washer
(3) Accessory Unit
Assembly

Figure 1

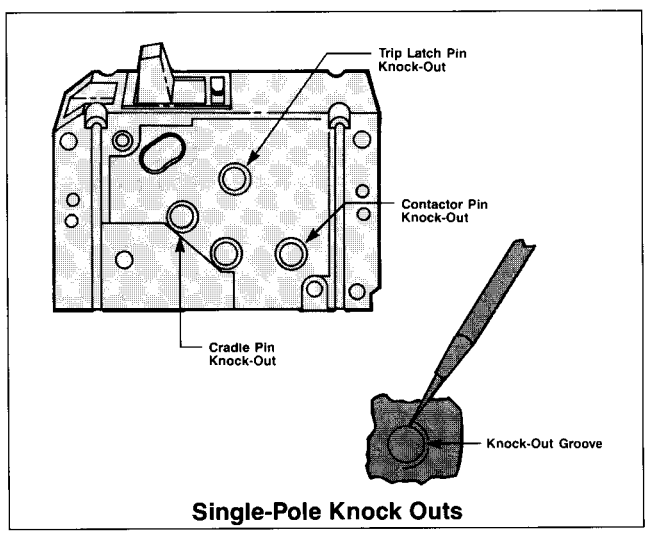


Figure 2

NOTE
Accessory module is used on all ED-Frame circuit breakers. Accessory *can not* be used with obsolete breaker types E2, E4, E6, HE4, HE6, CLE.

Mechanical Testing

Mechanical Operating Check

Shunt Trip and/or Undervoltage Trip

A. Reset the circuit breaker and turn handle to ON position. NOTE: With an undervoltage accessory assembled to the breaker without rated voltage applied to the coil, the breaker will not RESET and turn ON. Refer to Electrical Check on page 18.

B. While observing the slotted actuators in the accessory unit, turn the breaker OFF and ON several times. The blade actuator slot (**8**) should nearly align with the locating tab when the breaker is OFF. When the breaker is moved to the ON position, the slot should travel clockwise approximately 40° (Figure 3).

C. Place breaker in ON position and observe the trip latch actuator (**9**). The actuator slot should rotate a few degrees counterclockwise as the trip button (**10**) is depressed. After the breaker has tripped, the blade actuator slot and the cradle pin actuator slot (**11**) should nearly align with their respective locating tabs. (Figure 3).

Bell Alarm Switch

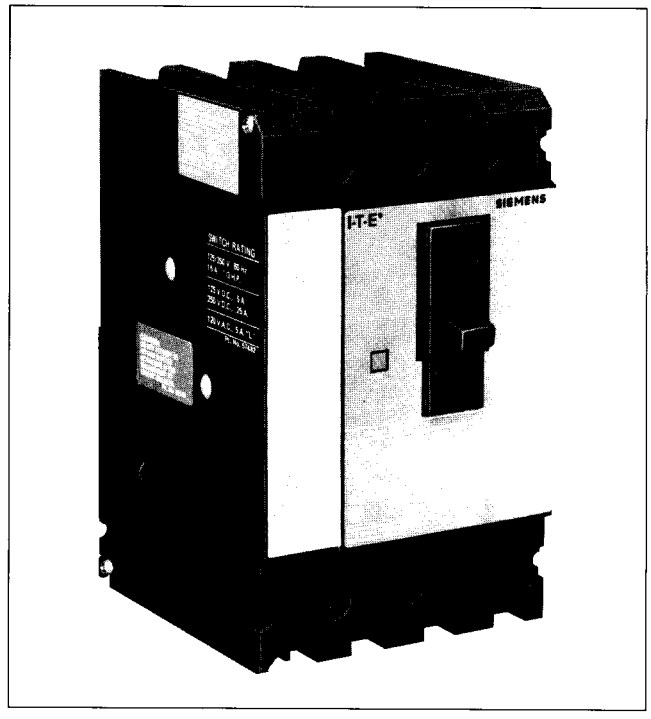
A. For units with bell alarm contacts and either undervoltage or shunt trip, follow above directions for shunt trip.

B. For bell alarm only. Reset breaker then turn to ON position. Trip the breaker, then observe the cradle pin actuator (**11**). The slot should nearly align with its locating tab (Figure 3).

Auxiliary Switch

A. For units with auxiliary contacts and either undervoltage or shunt trip, follow directions above for shunt trip.

B. For auxiliary contacts only. Reset the breaker, then turn it to the ON position. While observing the blade, turn the breaker OFF and ON several times. The slot in the blade actuator should nearly align with its locating tab when the breaker is in the OFF position. When the breaker is in the ON position, the slot should travel clockwise approximately 40° (Figure 3).



Circuit Breaker with Shunt Trip Attached

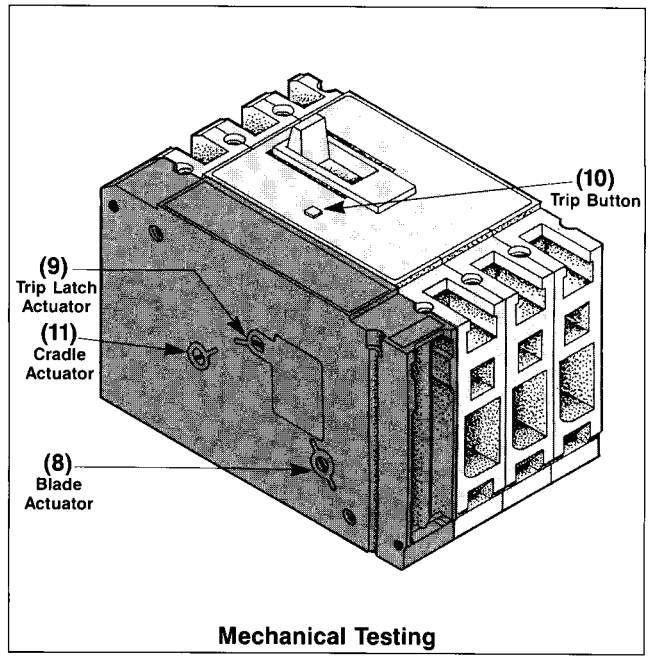


Figure 3

Recommended Combinations

Maximum Installable Accessory Combinations①

Shunt Trip	Undervoltage Trip	Auxiliary Switch	Bellalarm Switch
1	0	2	0
0	1	2	0
1	0	1	1
0	1	1	1

① Accessory combinations available only when ordered together. Additional accessories cannot be added to the combination at a later time. Always attach to left pole.

I-T-E Shunt Trip and Undervoltage Trip

Electrical Check

Shunt Trip

A. Reset and turn the circuit breaker handle to ON position.

B. Connect test circuit to accessory terminals 1 and 2 (Figure 1).

C. Preset test circuit voltage to 55 percent of the shunt trip voltage rating.

D. Apply the 55 percent voltage rating value to the shunt trip device. *It must trip.*

E. Remove test leads from terminals 1 and 2. Apply a continuity tester or ohm meter to the 1 and 2 terminals. Assure that coil limit contacts are open.

Undervoltage Trip

A. With the circuit breaker in the OFF position, apply variable voltage supply leads to the accessory terminals marked 1 and 2 (Figure 2).

B. Apply 100 percent of the accessory voltage rating to the undervoltage module.

C. Turn the circuit breaker to the ON position. Breaker must remain closed.

D. Reduce test voltage. Breaker must trip with voltage level between 70 and 35 percent of marked accessory rating.

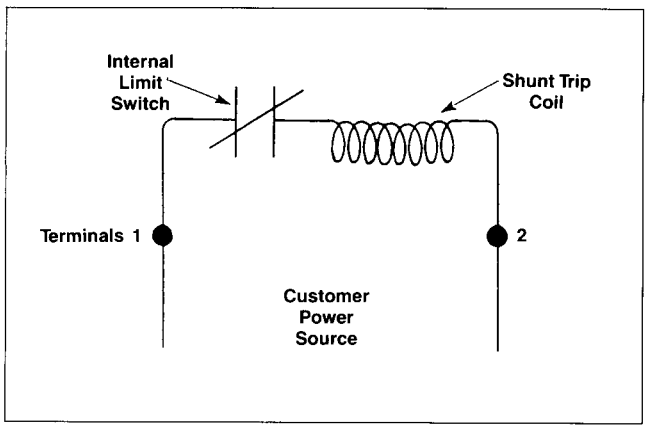


Figure 1

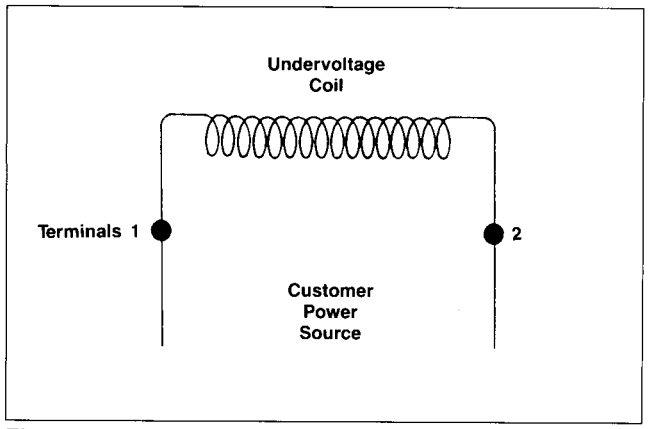


Figure 2

Electrical Data For Shunt Trip

Coil Voltage	Inrush Current At Rated Voltage (Amperes)	Catalog Number
60 Cycles AC		
24	1.200	S17ED60
48	0.800	S18ED60
120	0.395	S01ED60
208	0.265	S02ED60
240	0.165	S03ED60
277	0.190	S15ED60
480	0.145	S04ED60
600	0.080	S06ED60
DC		
24	2.20	S07ED60
48	1.20	S09ED60
125	0.50	S11ED60
250	0.35	S13ED60

Electrical Data For Undervoltage (UV) Trip

Coil Voltage	Sealed-In Current At Rated Voltage (Amperes)	Catalog Number
60 Cycles AC		
120	.030	U01ED60
208	.028	U02ED60
240	.016	U03ED60
277	.013	U16ED60
480	.008	U06ED60
600	.008	U08ED60
DC		
24	.110	U13ED60
48	.060	U14ED60
125	.027	U10ED60
250	.020	U12ED60

Shunt Trip and Undervoltage Trip Wiring Information

Tin plated accessory terminals, with binding head screws are provided. Terminals are suitable for use with No. 14-No. 22 AWG wire (Cu only) or 5/16 in. wide (max.) insulated crimp type connectors. Strip back wire 3/8 in. max.

Electrical Check

Auxiliary Switch Kits

Catalog Number	Number of Switches	Ampere Rating of Switch				
		Volts AC			Volts DC	
		120	240	480	125	250
A01ED62	1	5	15	—	.5	.25
A02ED62	2	5	15	—	.5	.25
A01ED64	1	15	15	15	.5	.25

All switch modules have 3 terminals (if single switch unit) 3, 5, 7; or 6 terminals (if double switch unit) 3, 5, 7-4, 6, 8.

Auxiliary Switch

A. Use a buzzer or light attached to switch leads 7 and 5 (8 and 6 if double auxiliary switch module). With breaker in ON position, a light or buzzing noise should not be observed.

B. Move handle to OFF position. Indicator light or buzzer should turn on.

C. Attach test to leads 7 and 3 (8 and 4 if double auxiliary switch module). Light or buzzer should turn off.

D. Move handle to ON position. Indicator light or buzzer should turn on. ①

① Should the indicator not function properly during "check" procedure, check for incorrect installation or wiring.

Bell Alarm Switch

A. Check continuity of "B" and "B1" contacts per accessory label. See "Bell Alarm Switch" information on page 17 for definition of normal position.

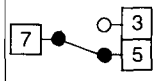
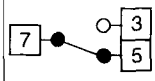
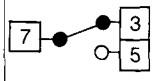
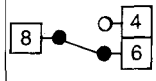
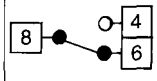
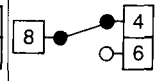
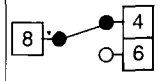
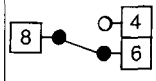
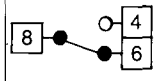
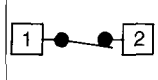
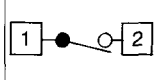
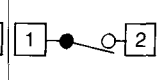
Auxiliary Switch and Bell Alarm Switch Wiring Information

Auxiliary and bell alarm switches are three wire (3W) devices except for catalog number A02ED62B where the bell alarm switch is a two wire (2W) device, using terminals (1 and 2). Terminal connections and function are indicated on the accessory label.

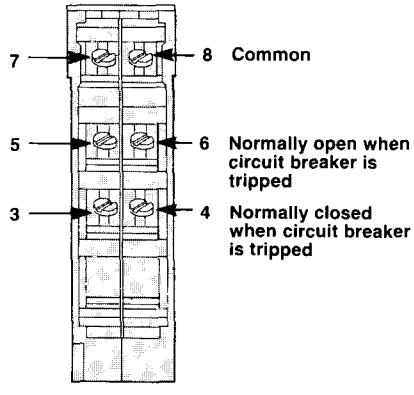
Auxiliary switch contacts are either Type "A" or Type "B". Bell alarm switch contacts on three wire (3W), devices can be open or closed in the normal position. On two wire (2W) bell alarm switches, the contact is open in the normal position. The normal position refers to the deenergized state or OFF position of the circuit breaker. Auxiliary switch contacts are actuated when the circuit breaker closes. Type "A" contacts are OPEN when the breaker is OPEN. Type "B" contacts are CLOSED when the breaker is OPEN. Bell alarm switch contacts are actuated when the circuit breaker TRIPS.

Tin plated accessory terminals, with binding head screws are provided. Terminals are suitable for use with No. 14-No. 22 AWG wire (Cu only), or 5/16 in. wide (max.) insulated crimp type connectors. Strip back wire 3/8 in. max.

Auxiliary and Bell Alarm Switch Terminal Number and Contact Position Diagram

Accessory	Breaker Condition		
	TRIP	OFF	ON
Auxiliary Switch			
Second Auxiliary Switch ①			
Alarm Switch			
Alarm Switch Catalog Number A02ED62B Only			

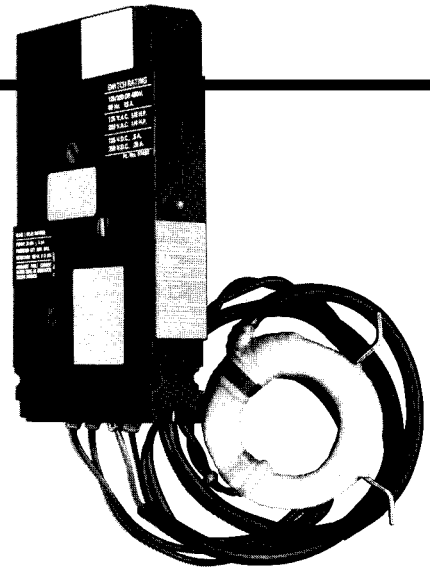
① Used for devices containing two auxiliary switches, all Shunt Trip and Undervoltage Trip catalog numbers having an "AA" suffix and Auxiliary Switch catalog numbers A02ED62 and A02ED62B.

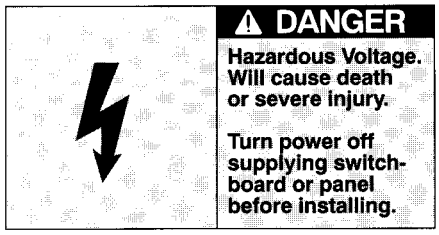


End View of Bell Alarm Switch

Figure 1

I-T-E Ground Fault Sensor





SAFETY INSTRUCTIONS

General Information

The ground fault circuit sensor/relay module kit functions to de-energize a circuit or portion of a circuit within an established period of time when the current to ground exceeds a predetermined value less than that required to operate the circuit breaker. It performs this operation by detecting 5mA ± 1 or 30mA ± 6 current difference between two or more load conductors passing through the sensor and actuating the relay to trip the circuit breaker. This current difference normally occurs from a low level ground fault in the load circuit, when load is supplied from a grounded power system.

The relay electronics operates from a 120V ac (66-132v) absolute limits, 60 Hz control power source not necessarily related to the load circuit monitored by the sensor. The relay module trip mechanism includes an auxiliary switch contact to de-energize the electronics when the relay module trips the attached circuit breaker.

NOTES: Never attempt to add more than one accessory module to the circuit breaker.

This device is not intended for personnel protection against electrical shocks.

These sensors are to be used for equipment protection application only.

Installation/Test Procedure

A. Refer to "Circuit Breaker Preparation" (pages 16-17) for breaker preparation, module mounting, mechanical testing (see "Shunt Trip and/or Undervoltage Trip") and electrical testing of bellalarm contacts (if required).

B. The ground fault relay module can be used only with I-T-E Sensor #64232. Mounting hardware for sensor is supplied (#10-32 x 3/8 in. screws and lockwashers). Mount circuit breaker/relay assembly and sensor as required.

C. Sensor comes pre-assembled with leads, terminals and mounting feet. Sensor will accommodate four #1 AWG or smaller type TW conductors, or equivalent. Connect control source, sensing leads, PUSH TO TEST leads, and bell-alarm contacts (if required) to terminals on bottom of relay. See Figure 1 for the proper terminal connections.

D. Connect load circuit wiring (Figure 2).

E. *Control power for relay must be 120V ac (66V-132V), 60 Hz. Continuous: .010A at 120V ac. Inrush (trip): .8A pk max. at 120V ac.*

Response Time

Threshold Level—approximately 2 seconds
115 percent of pickup—.70 second maximum
150 percent of pickup—.30 second maximum
250 percent of pickup—.20 second maxumum

With the control source energized, push test button on face of relay module. The breaker should trip immediately. Reset by moving breaker handle to the fully OFF position, then to the ON position. Repeat the trip and reset procedure. The assembly is now fully operational. Periodic retesting is recommended to verify continued protection.

Testing Circuit

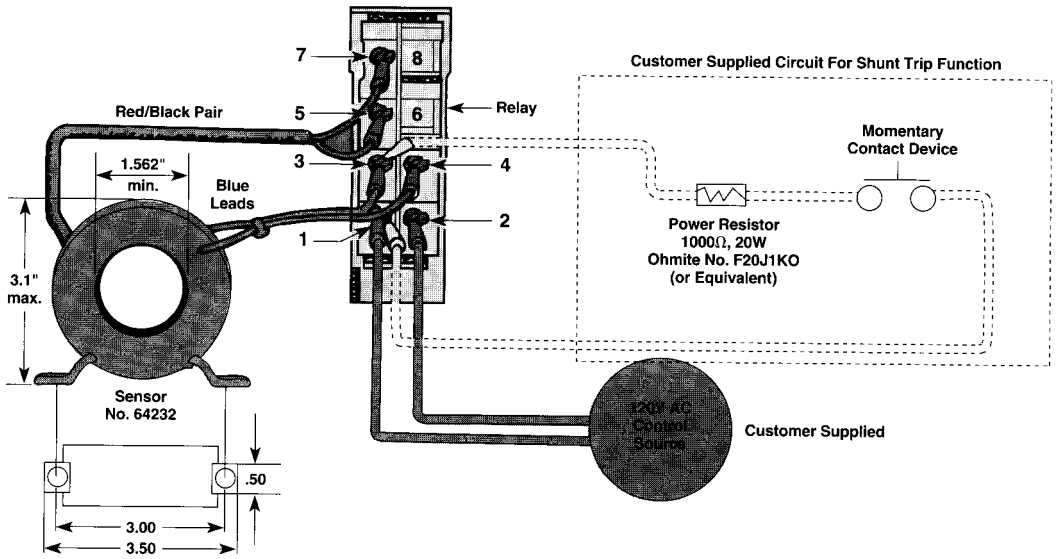
Momentary PUSH TO TRIP switch on face of relay initiates a simulated fault current through blue sensor leads (when energized at 120V ac).

NOTE: Circuit leakage from the load may add to or subtract from the test current, depending on circuit phase relationships. In the event of test difficulty, check control voltage and load circuit leakage. Some installation may require reversing the blue sensor lead connections for proper test circuit operation.

NOTE

Accessory module is used on all ED-Frame circuit breakers. Accessory *can not* be used with obsolete breaker types E2, E4, E6, HE4, HE6, CLE.

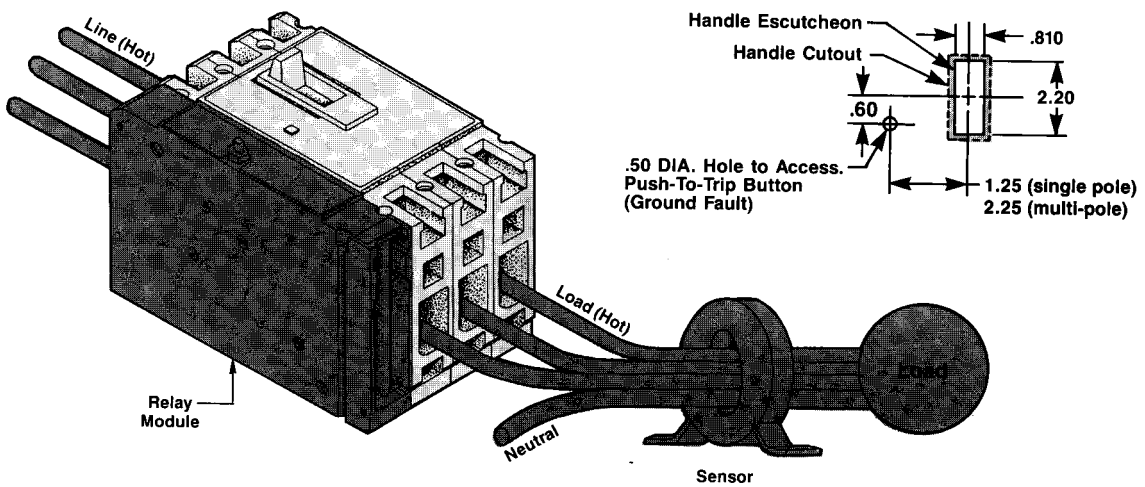
Installation Diagrams



Terminal Functions	
1 & 2	120V AC Control
3 & 4	Push to Test Leads
5 & 7	Sensing Leads
6 & 8	Bell Alarm (if any)
1 & 3	Shunt Trip (Functions when wired per this sketch)

Relay Catalog Numbers		Sensitivity (mA)
GF01E60	No Bell Alarm	30±6
GF01E60BO	Normally Open Bell Alarm Contact	30±6
GF01E60BC	Normally Closed Bell Alarm Contact	30±6

Figure 1



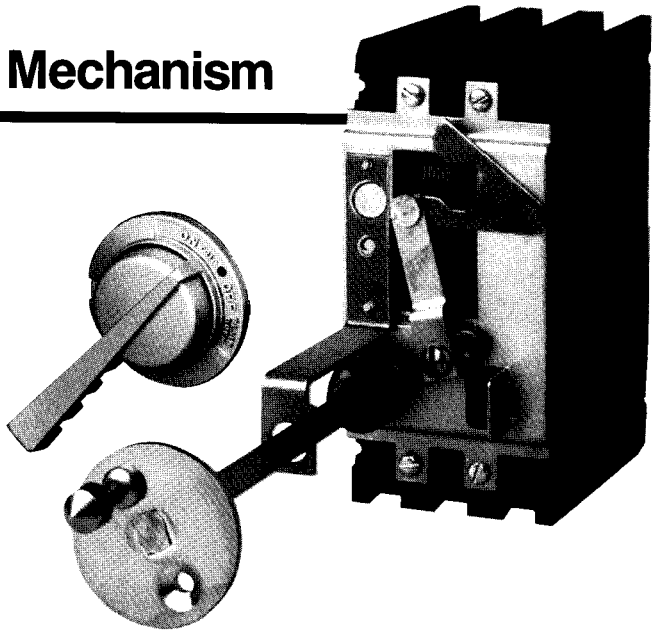
Load Circuit Wiring②

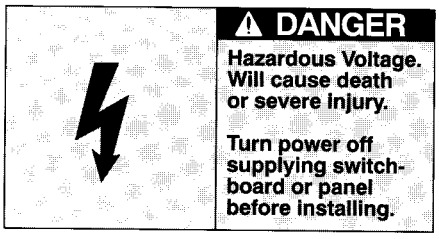
Figure 2

① Ground fault relay module can also be used on 1 or 2-pole ED-Frame circuit breakers.
② Accessory module is used on all ED-Frame circuit breakers.

I-T-E Rotary Handle Enclosure Mechanism

Types 1, 12




⚠ DANGER
Hazardous Voltage. Will cause death or severe injury.
Turn power off supplying switchboard or panel before installing.

⚠ SAFETY INSTRUCTIONS

Standard Depth (D11CEU1)
Variable Depth (D11CEU2)

General

Handle will permit locking the disconnect device in the OFF position using up to three locks having shackles up to 3/8 in. in dia. Provision for locking in ON position is provided, but the handle plate must have the material covering the locking notch removed. This can be done with a hacksaw or file. The handle has a voidable interlock. Voiding the interlock requires inserting a small screwdriver into the rectangular opening in the handle plate, which will release the handle.

Mounting Instructions

A. Drill and tap breaker mounting holes as shown in Figure 1.

B. Measure distances **A** and **B** from mounting holes to walls of the enclosure (Figure 2).

C. Find handle center dimensions **D** and **E** by adding enclosure thickness and cover overhang (C_1 and C_2) to **A**-1/2 and **B** + 3.985. Drill hole **X** (2¼ in. dia.) and drill either holes **Y** or **Z** (5/16 in. dia.) depending on handle orientation required (Figure 2a).

D. If installing variable depth kit, measure distance **F** from breaker mounting surface to outside of cover (Figure 3). If distance **F** is less than 8 in., remove shaft guide bracket.

E. Find length **G** by subtracting F from 16 5/8 in. Mark length **G** from end of operating shaft and cut shaft squarely at mark (Figure 3a).

F. Breaker must be "tripped" during installation. Push red button marked PUSH TO TRIP.

G. Using screws supplied with kit, attach mechanism plate to breaker and mount in enclosure in position shown.

H. Insert end of operating shaft into square socket in cast operating arm so that top of shaft has proper relationship to handle. Tighten set screw in operating arm (recommended torque: 75 in. lb.)

I. Place handle and cork gasket on outside of cover and place handle mounting bracket on inside of cover; fasten together loosely through cover with the two short screws provided.

J. Adjust handle so that cover will not open when handle is in OFF position but will open when handle is between OFF and RESET/OPEN positions. Tighten screws and operate handle ON and OFF to see that circuit breaker operates satisfactorily.

Installation Diagrams

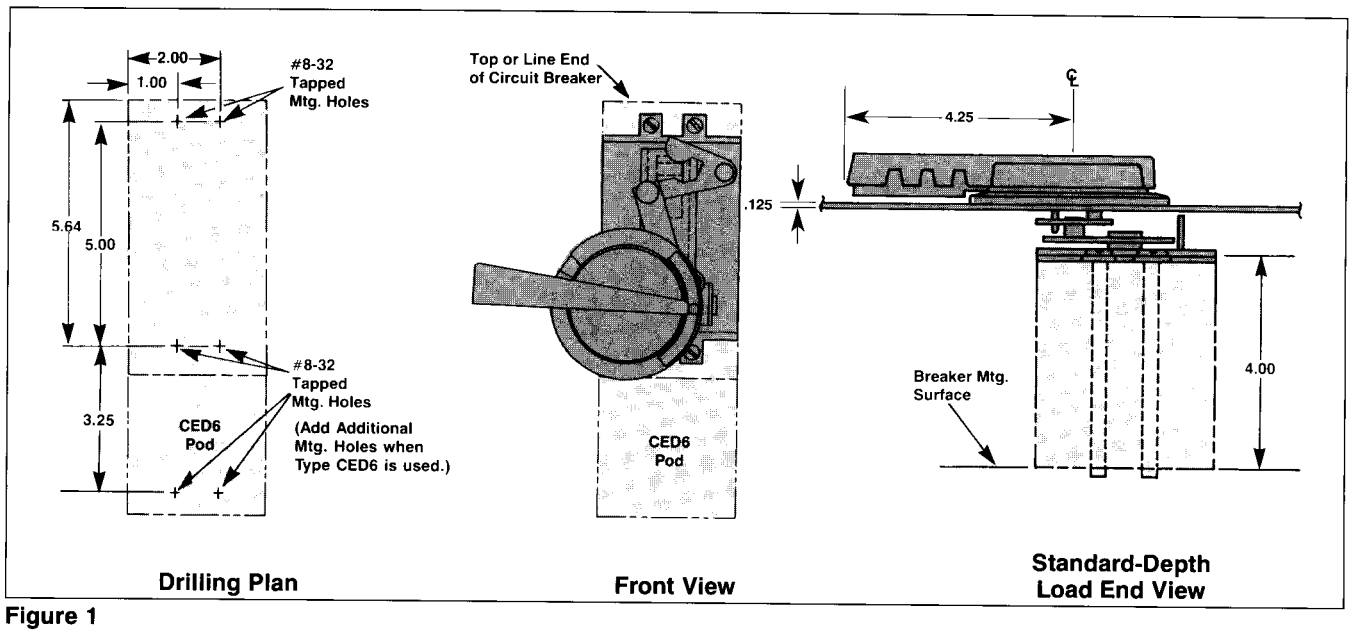


Figure 1

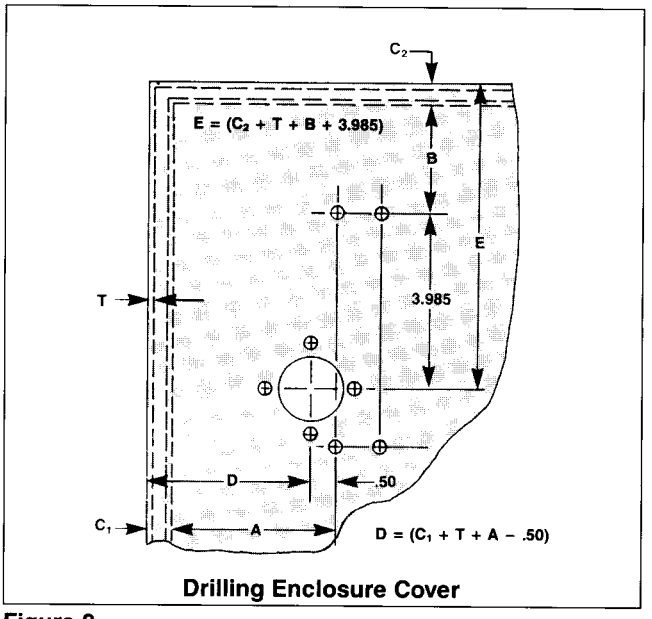


Figure 2

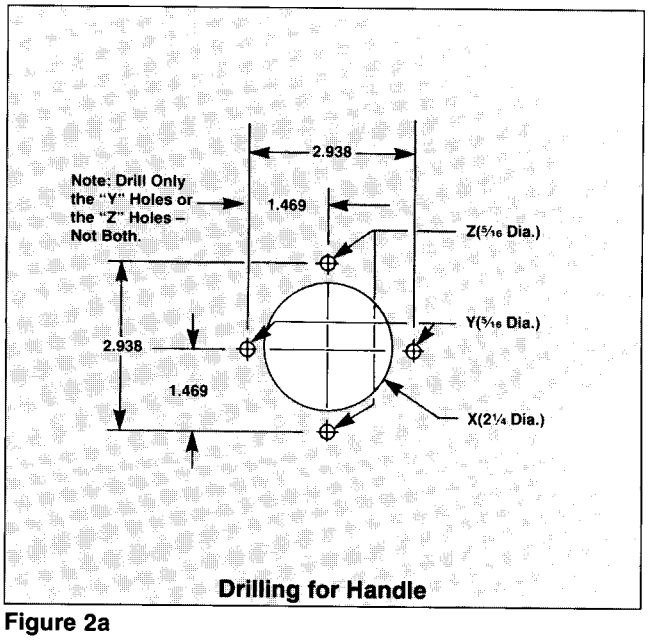


Figure 2a

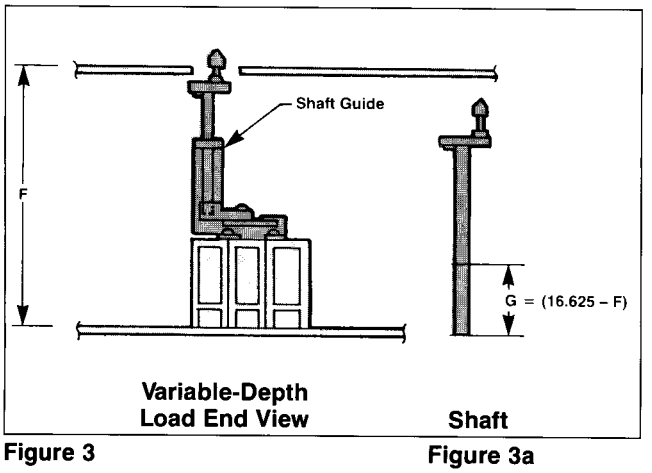
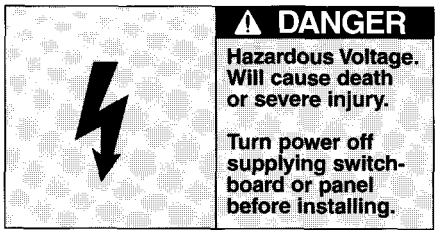


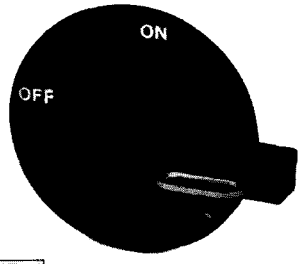
Figure 3

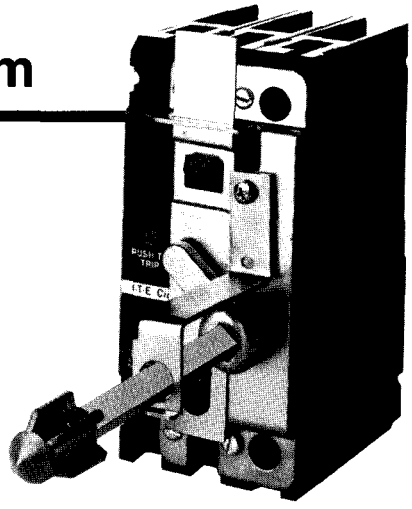
Figure 3a

I-T-E Rotary Handle Enclosure Mechanism

Types 1, 12







⚠ SAFETY INSTRUCTIONS

Standard-Depth (CRHOESD) Variable-Depth (CRHOEVD)

General Information

When properly installed, the rotary handle operator provides single point latching of the enclosure door. For maximum protection against unauthorized entry into the enclosure, additional latching means should be provided. The handle can be padlocked in the OFF position with up to three 5/16 in. padlocks. The breaker operator can also be padlocked in the OFF position.

Drilling of Enclosure

A. Catalog number RHOSSD standard depth shafts are used for minimum depth enclosures. Refer to minimum dimension **K** in Figure 2.
Catalog Number RHOSVD variable depth shafts are used for all other enclosure depths. Shafts are cut to length **L** as shown in Figure 3.

B. Drill and tap circuit breaker mounting holes in breaker mounting surface (**1**) and handle mounting holes in enclosure door (**2**) as shown in Figure 1.

Installation of Breaker and Breaker Operator

A. Attach the circuit breaker (**3**) and breaker operator (**4**) to the enclosure panel using the four mounting screws and lockwashers (**5**) as shown in Figure 3. Tighten to 20 in. lb.

NOTE:
For Type 4 and 4x applications use Handle Catalog No. RHOH4 and appropriate illustrations.

Installation of Shaft (RHOSSD, RHOSVD)

A. Shaft length for Variable Depth Operators **L = K**—3.32 in. Attach the shaft **(6)** to the operating arm **(7)** of the breaker operator and tighten the set screw to 70 in. lb. min.

NOTE: The proper orientation of the "wings" **(8)** (shown in off position) at the end of the shaft when the breaker is in the OFF position (Figure 4).

NOTE: It is recommended that the shaft support bracket **(9)** be installed if the enclosure depth exceeds 10 in. Attach as shown in Figure 3. Tighten screw to 45 in. lb.

NOTE: RHOSSD Shaft is 2.93" Long
RHOSVD Shaft is 13.25" Long

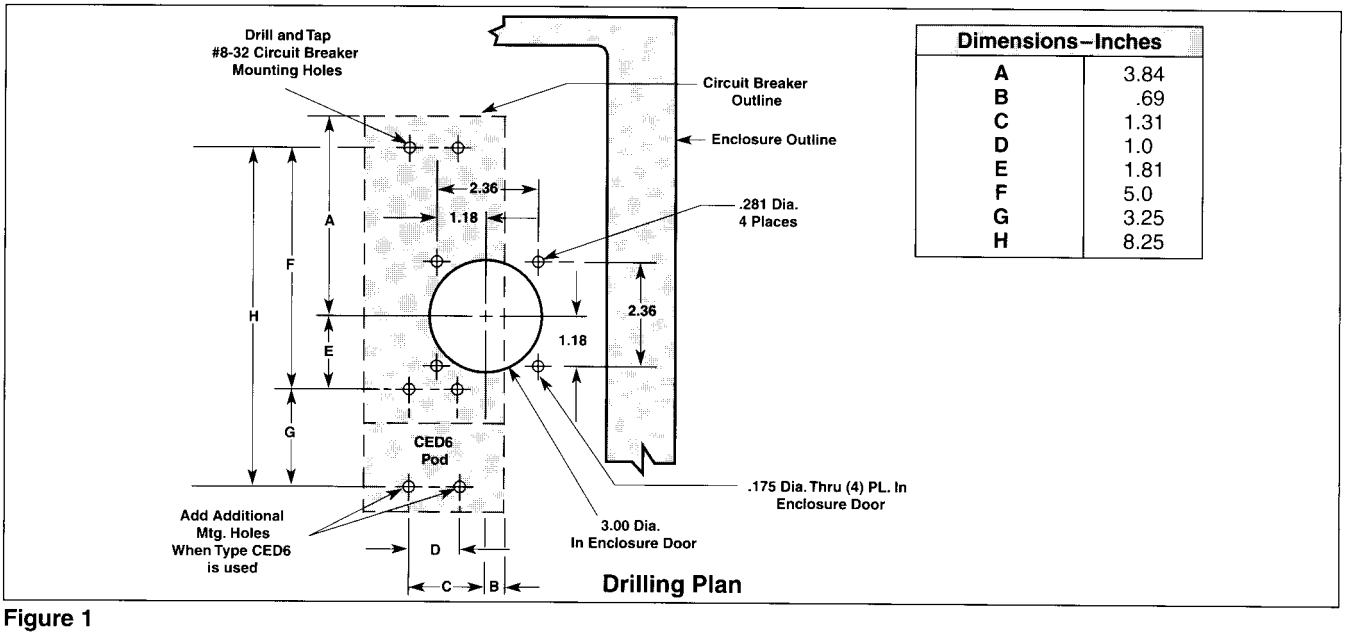
Installation of Handle (CRHOH)

A. Attach the handle **(10)** and gasket **(11)** to the enclosure door **(12)** and secure with four bolts, flatwashers, lockwashers and nuts supplied **(14)**. Tighten nuts to 75 in. lb. (Figure 5).

B. When the enclosure door is closed, check if the handle interlocks with the shaft in all handle positions except RESET/OPEN. To open the enclosure door when the breaker is in the ON position rotate the screw slot on the handle plate counter-clockwise. This procedure will defeat the interlock.

C. To lock handle in OFF position, pull the lockplate **(15)** from the handle and insert up to three 5/16 inch padlocks.

Installation Diagrams



Dimensions–Inches	
A	3.84
B	.69
C	1.31
D	1.0
E	1.81
F	5.0
G	3.25
H	8.25

Figure 1

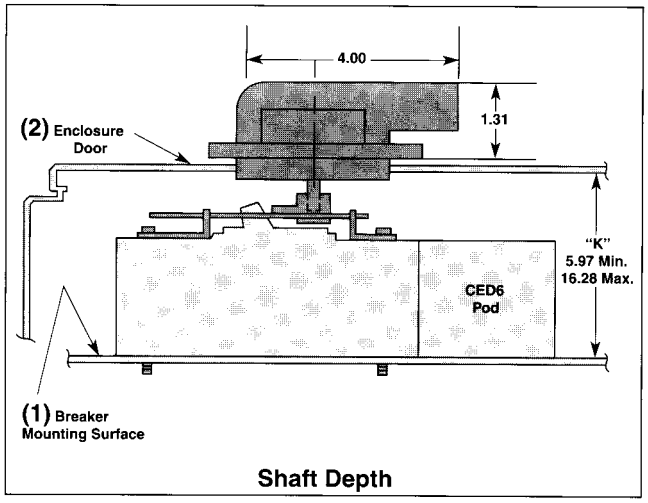


Figure 2

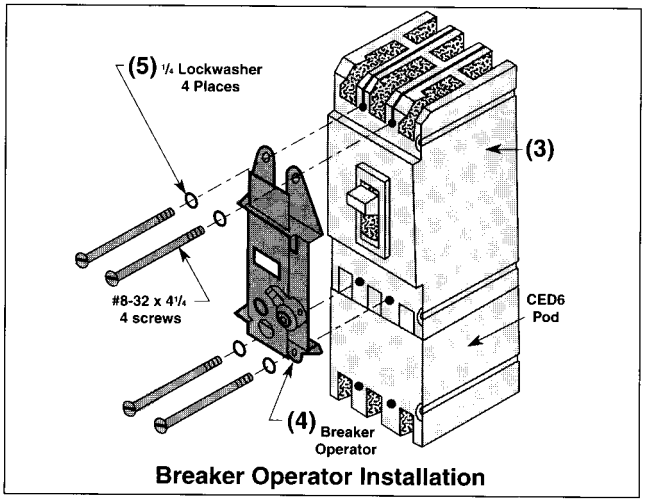


Figure 3

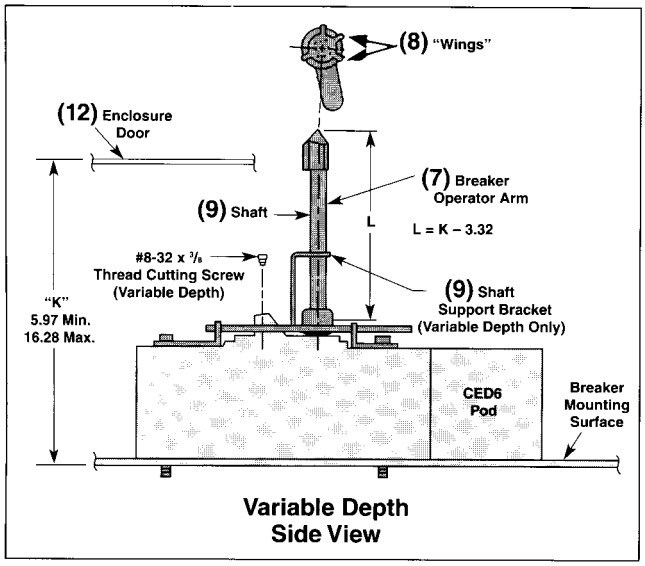


Figure 4

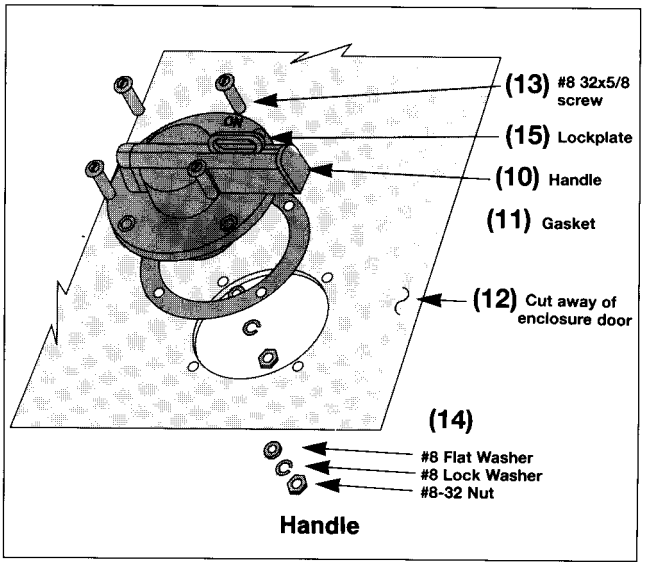
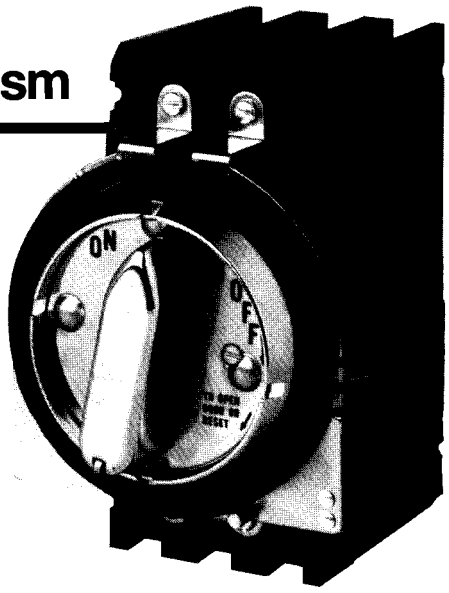


Figure 5

I-T-E Rotary Handle Enclosure Mechanism

Types 1, 12



⚠ DANGER

Hazardous Voltage. Will cause death or severe injury.

Turn power off supplying switchboard or panel before installing.

⚠ SAFETY INSTRUCTIONS

Standard-Depth (E2RH1)

Drilling of Enclosure

A. Drill breaker mounting holes **H** (1) in the enclosure per drilling plan on outline drawing (Figure 1).

B. Place template on breaker mounting surface so that the four centers in the template line up with the breaker mounting holes. Make sure ON-OFF indications on template are in same direction as ON-OFF indications on the breaker. To hold template in place, punch two holes in template with breaker mounting screws and tighten into breaker mounting holes.

C. Measure distances **N** and **P** from walls of enclosure (Figure 2).

D. Relocate template on enclosure cover by adding enclosure thickness and cover overhang **R** to dimensions **N** and **P** (Figure 3).

E. Remove backing from template and secure template on door.

F. Drill holes **J** (⅜ in. dia.) and **K** (4¼ in. dia.) on template (Figure 3).

Circuit Breaker/Rotary Handle Mechanism Mounting

A. Mount breaker with handle up by sliding it under the tabs in the mounting plate.

B. With breaker in OFF position and rotary handle mechanism in OFF position, mount mechanism on breaker using four #8-32 x 4¼ in. screws. When mounting ED-Frame breakers with any handle operator, four spacers must be used as shown in Figure 4. Make sure opening in mechanism lever engages breaker handle. Tighten screws.

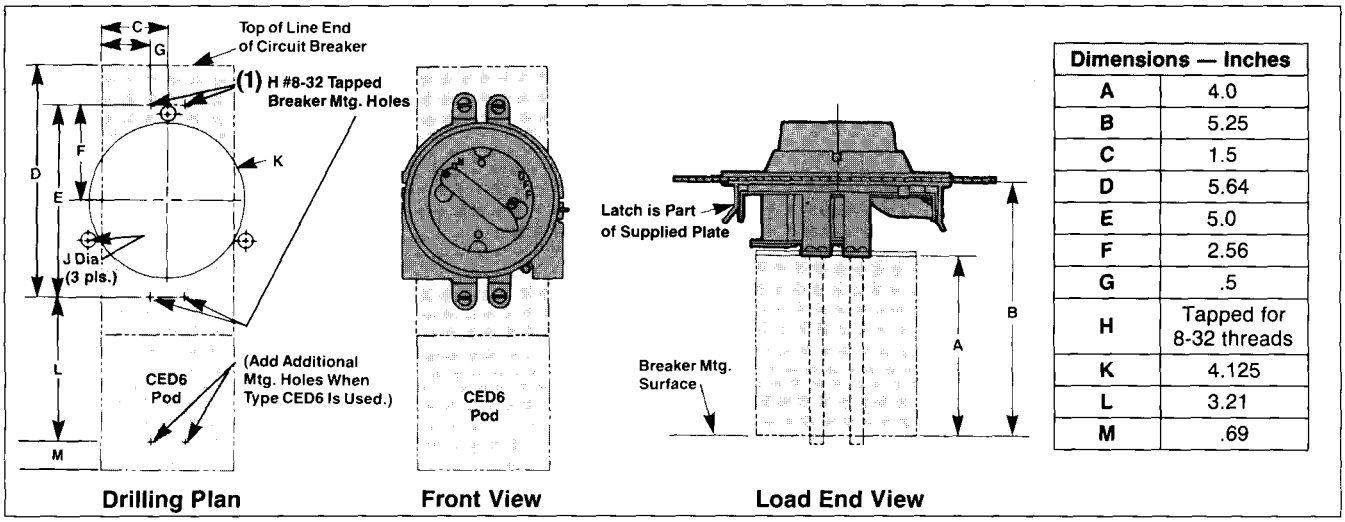
C. Loosely secure the door rings with the three #6-32 x ¼ in. screws provided. Position the interior ring (**2**) (contains latch tabs and threaded holes) as shown in Figure 5. The exterior ring mounts on the outside of the door with the small flange to the inside (Figure 6).

D. Close the enclosure door and adjust external ring on door so it is concentric with handle ring. Tighten the three screws (**4**).

E. Check the door operation. Latch on mechanism should engage latch tab (**3**) interior ring when breaker is ON and disengage latch tab when handle is rotated to OPEN DOOR position. Repeat Step C if a slight adjustment is necessary.

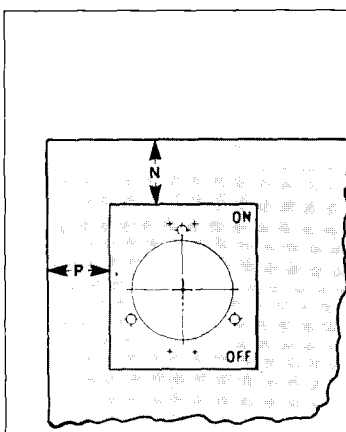
F. Enclosure door may be opened when breaker is ON by turning defeater screw (**5**) on rotary handle face place (Figure 4) in a clockwise direction.

Installation Diagrams



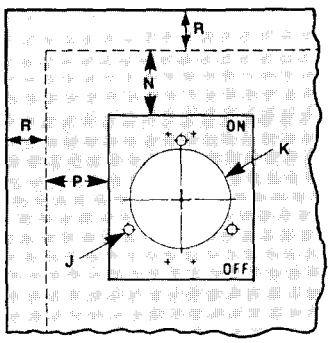
Dimensions — Inches	
A	4.0
B	5.25
C	1.5
D	5.64
E	5.0
F	2.56
G	.5
H	Tapped for 8-32 threads
K	4.125
L	3.21
M	.69

Figure 1



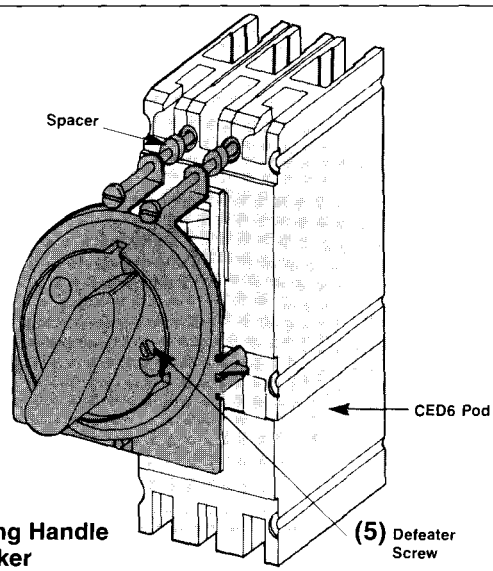
Breaker Mounting Surface

Figure 2



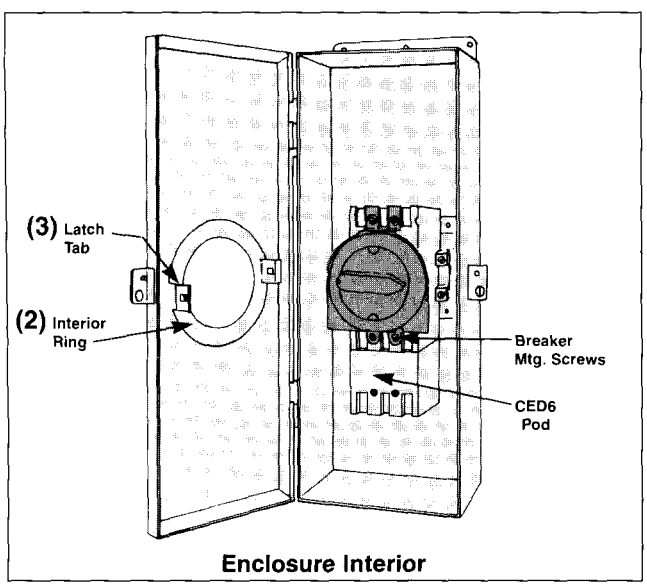
Enclosure Cover

Figure 3



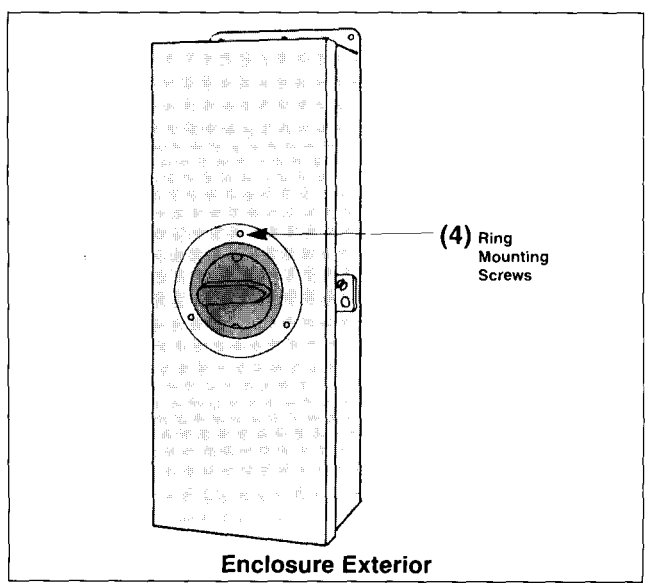
Mounting Handle to Breaker

Figure 4



Enclosure Interior

Figure 5

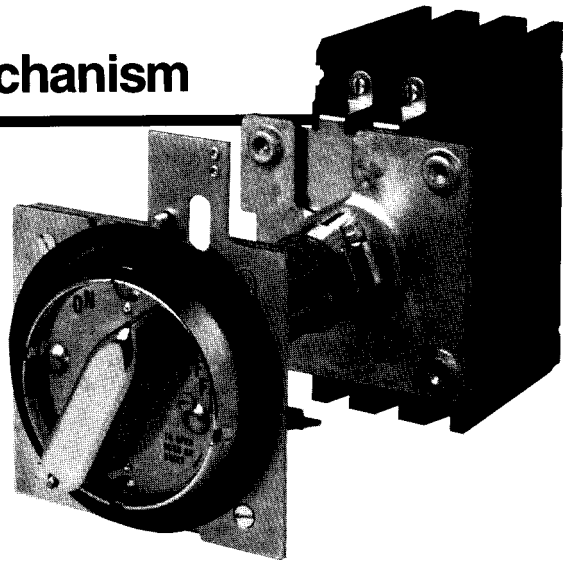


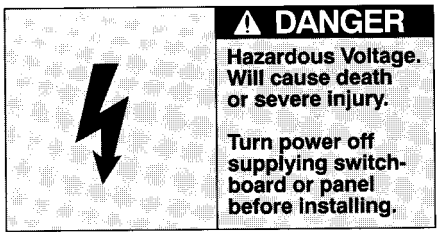
Enclosure Exterior

Figure 6

I-T-E Rotary Handle Enclosure Mechanism

Types 1, 12




⚠ DANGER
Hazardous Voltage. Will cause death or severe injury.
Turn power off supplying switchboard or panel before installing.

⚠ SAFETY INSTRUCTIONS

Variable Depth (E2RHV [3], [5], [7] or [9])①

INSTALLATION INSTRUCTIONS

Drilling of Enclosure

A. Drill breaker mounting holes **H** (1) in the enclosure per drilling plan on outline drawing (Figure 1).

B. Place template on breaker mounting surface so that the four centers in the template line up with the breaker mounting holes. Make sure ON-OFF indications on template are in same direction as ON-OFF indications on the breaker. To hold template in place, punch two holes in template with breaker mounting screws and tighten into breaker mounting holes.

C. Measure distances **N** and **P** from walls of enclosure (Figure 2).

D. Relocate template on enclosure cover by adding enclosure thickness and cover overhang **R** to dimensions **N** and **P** (Figure 3).

E. Remove backing from template and secure template on door.

F. Drill holes **J** (3/8 in. dia.) and **K** (4 1/8 in. dia.) on template (Figure 3).

Circuit Breaker/Rotary Handle Mechanism Mounting

A. Mount breaker with handle up by sliding it under the tabs in mounting plate.

B. With breaker in OFF position and rotary handle mechanism in OFF position, mount mechanism on breaker using four #8-32 x 4¼ in. screws. When mounting ED-Frame breakers with any handle operator, four spacers must be used as shown in Figure 4. Make sure opening in mechanism lever engages breaker handle. Tighten screws.

C. Loosely secure the door rings with three #6-32 x ¼ in. screws as provided. Position the interior ring (**2**) (contains latch tabs and threaded holes) as shown in Figure 5. The exterior ring mounts on the outside (Figure 6).

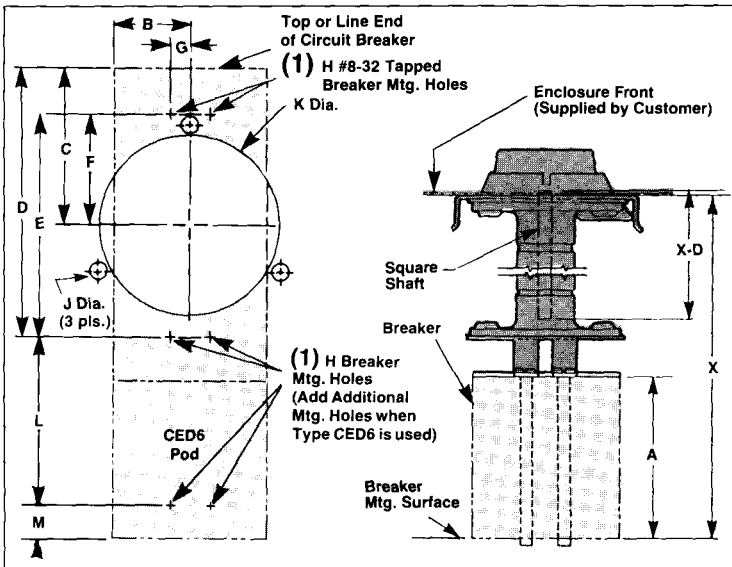
D. Close the enclosure door and adjust external ring on door so it is concentric with handle ring. Tighten the three screws (**4**).

E. Check the door operation. Latch on mechanism should engage latch tab (**3**) interior ring when breaker is ON and disengage latch tab when handle is rotated to OPEN DOOR position.

F. Enclosure door may be opened when breaker is ON by turning defeater screw (**5**) on rotary handle face plate (Figure 4) in a clockwise direction.

①Use (3), (5), (7) or (9) as a suffix number. This indicates pipe length as related to enclosure depth.

Installation Diagrams

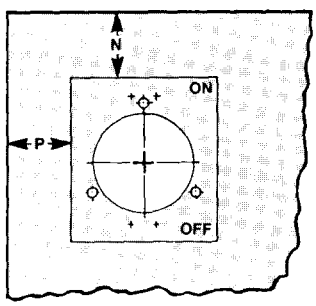


Dimensions — Inches	
A	4.0
B①	1.50
C	3.188
D	5.312
E	5.0
F	2.563
G	.50
H	Tapped for 8-32 threads
J	3.75
K	4.125
L	3.21
M	.69

X-Enclosure Depth (Inches)		
Pipe Length	Min.	Max.
3	9.0	11.0
5	11.0	13.0
7	13.0	15.0
9	15.0	17.0

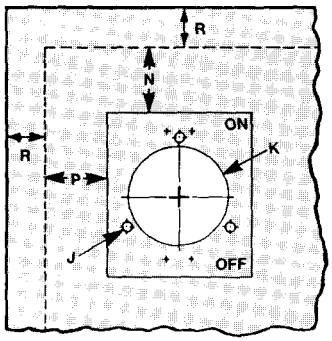
① 3-pole. Dimension shown is for 3-pole unit without accessory section. For breaker with accessory section add 1 in. to B dimension.

Figure 1



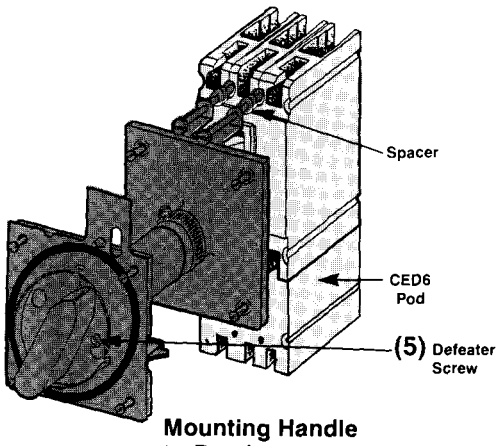
Breaker Mounting Surface

Figure 2



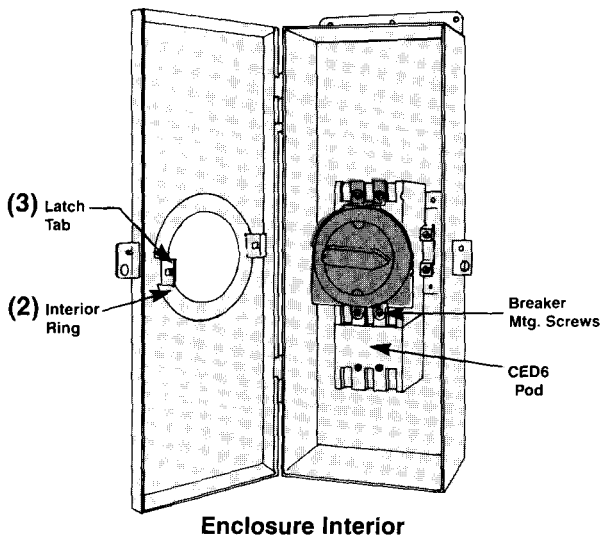
Enclosure Cover

Figure 3



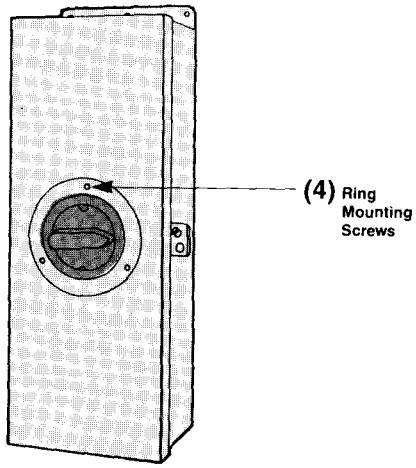
Mounting Handle to Breaker

Figure 4



Enclosure Interior

Figure 5



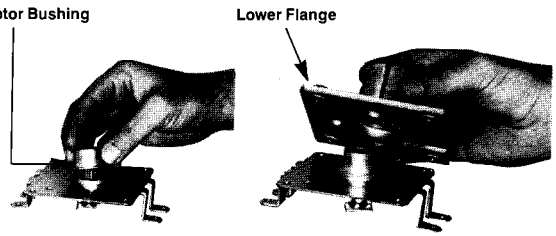
Enclosure Exterior

Figure 6

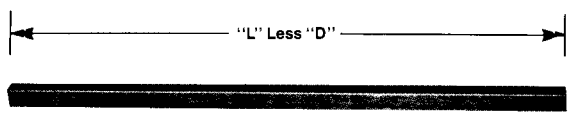
I-T-E Rotary Handle Enclosure Mechanism

Types 1, 12 — Mechanical Assembly

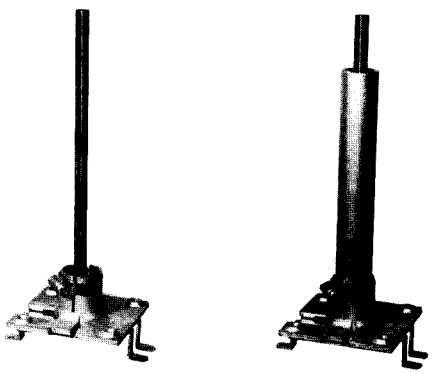
Variable-Depth (E2RHV [3], [5], [7] or [9])①



A. With adapter bushing in place on bearing of lower mechanism, place lower flange (flange with the four tapped holes) on to the lower mechanism. Secure with four flat head screws.

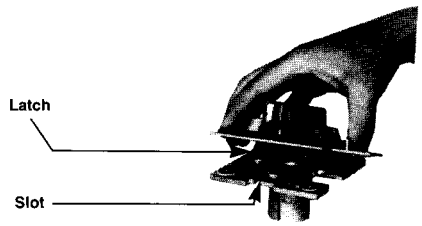


C. Cut square shaft to desired dimension. To do this subtract dimension **D** (see dimension chart on page 29) from **M** dimension which is the distance from the back of the breaker to inside of enclosure door.

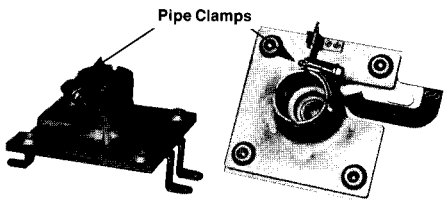


E. Place square shaft into bushing on lower mechanism and then place support pipe over this shaft and into collar or flange.

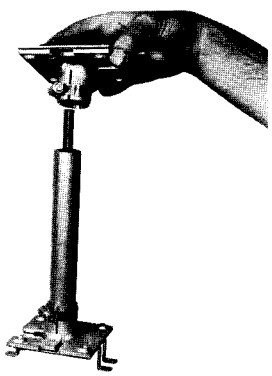
G. Lay assembly on flat surface (this will square assembly). If **M** dimension is the minimum, as shown on dimensional chart, tighten pipe clamps with support pipe seated fully into both flange collars. If **M** dimension is other than minimum, adjust support pipe so that approximately the same amount of pipe is in each of the upper and lower flange collars. (A minimum of ½ in. pipe must be in each flange collar.) Tighten pipe clamps.



B. Place upper mechanism on upper flange (flange with four tapped holes) and secure with four flat head screws. Be sure latch on mechanism fits into elongated slot in flange.

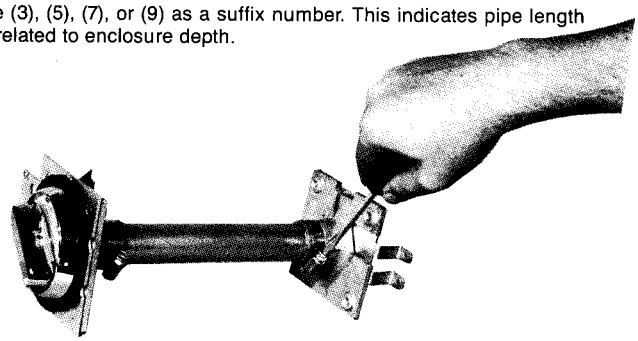


D. Place pipe clamp on the collar of each flange. Do not tighten.



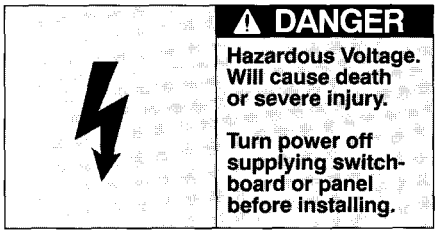
F. With both lower and upper mechanisms in OFF position (lower mechanism is OFF when square shaft is turned fully to the right) place upper mechanism on to support pipe. Make sure square shaft engages upper mechanism.

①Use (3), (5), (7), or (9) as a suffix number. This indicates pipe length as related to enclosure depth.



I-T-E Max-Flex™ Flange-Mount Handle Operator①

Types 1, 3, 3R, 4, 4X, 12



⚠ SAFETY INSTRUCTIONS

GENERAL INFORMATION

Description

The I-T-E Max-Flex™ Flange-Mount Handle Operator is a flexible cable control device used for the remote switching of a circuit breaker within an enclosure. The flexible cable is connected directly to the breaker switch handle at one end and a factory installed switch handle operator at the other end. The remote operator handle, located on the enclosure flange, is used to perform mechanical open/close switching operations. This is accomplished through the cable's sliding center race enclosed within the cable.

Function

The advanced design concept of the Max-Flex Handle Operator provides for greater flexibility when locating a circuit breaker within an enclosure. The circuit breaker can be mounted almost anywhere, at any angle and on almost any convenient surface. The same flexibility applies when locating the switch handle operator on the flange section of the enclosure.

Application

The Max-Flex Operator is designed to work with I-T-E circuit breakers having current ratings through 600A. The Max-Flex unit meets all the industrial criteria such as UL and Automotive Industry Standards.

Design

The new Max-Flex Handle Operator provides maximum flexibility in design and assembly of electrical equipment. Since there are no linkages to assemble, the Max-Flex system can save time during installation.

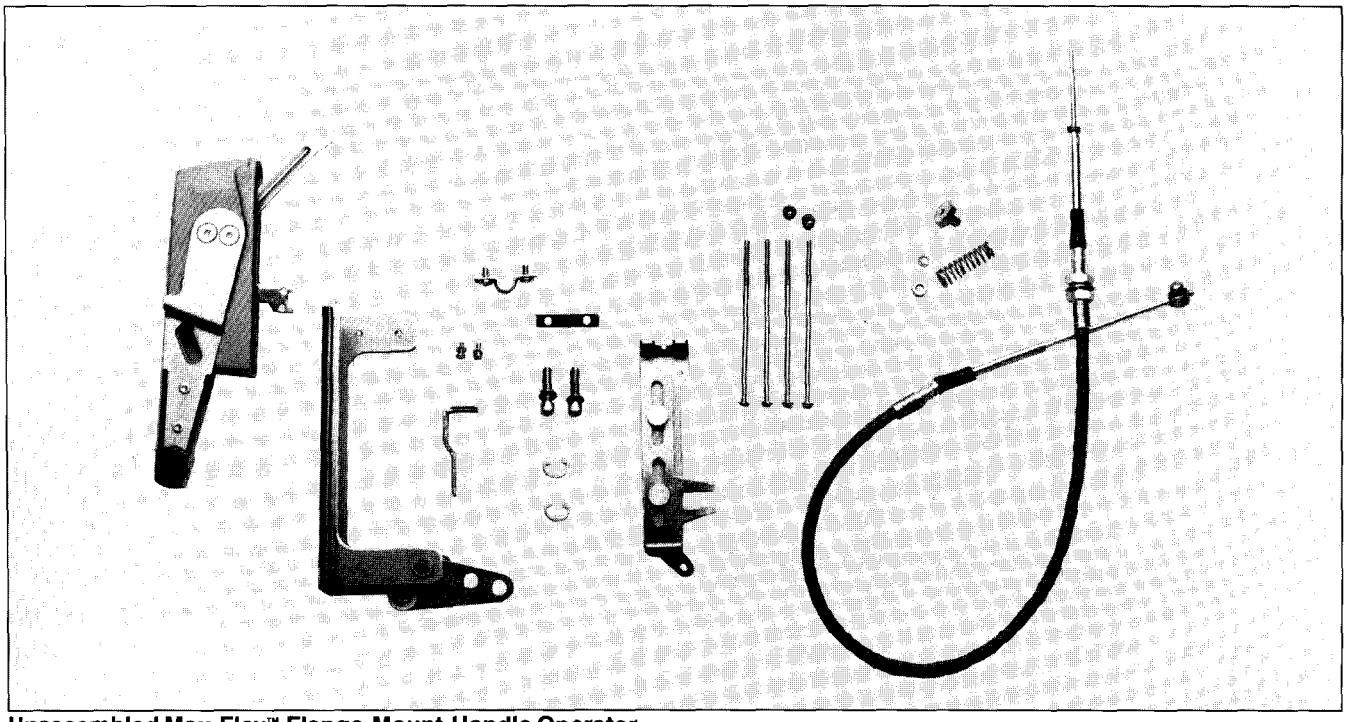
The cable design is flexible and rugged. It is similar to those cables used in aircraft control systems. The flexible cable comes in standard 3 or 4 ft. lengths. However, specific lengths can be special ordered up to 20 ft.

Operation

When properly installed, the Max-Flex Handle Operator is used to perform remote switching operations from outside of the enclosure. Switching is accomplished by pushing the Max-Flex Handle Operator up for ON and down for OFF. The mechanical advantage gained with this device simplifies switching operations when compared with local switching at the breaker.

This unique design offers breaker trip indication as a standard feature. Interlocking provisions are included and described below. All switching functions are standard to accepted practices.

①Accessory can be used on 3-pole circuit breakers only.



Unassembled Max-Flex™ Flange Mount Handle Operator

I-T-E Max-Flex™ Flange-Mount Handle Operator

Types 1, 3, 3R, 4, 4X, 12

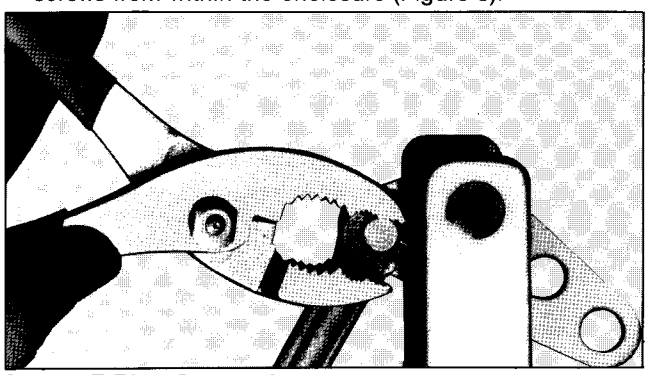
INSTALLATION

Mounting Max-Flex™ Handle Operator to Enclosure Frame Assembly

A. Drill the mounting holes in the enclosure flange and file all burrs (Figures 1 and 2). Note the maximum and minimum drill hole distances in Figure 2.

B. Push the rubber gasket (**1**) down in the groove of the handle assembly (**2**) (Figure 3).

C. The handle and the interlock mechanism are supplied preassembled from the factory. NOTE: For ease of assembly, move the operating handle to the ON position. (up toward the top of the enclosure). Mount the frame (**4**) and handle assembly (**2**) to the enclosure flange (**5**) with two #¼-20 x 1 in. socket head cap screws and lockwashers. Tighten cap screws from within the enclosure (Figure 3).



Secure E-Ring Connection

A. Rotate the bellcrank (**6**) clockwise to engage the return spring (**7**). Hold the bellcrank in position and place the plastic washer and connecting link onto the bellcrank pin (**8**). Using pliers, secure the connection with an E-ring (**9**) (Figure 3).

B. Mount the interlock lever extension (**10**) to the interlock lever (**3**) using two #6-32 x 3/8 in. machine screws and lockwashers. Screws mount through the threaded lever extension into the lever (Figure 3).

Operating Note: With the enclosure door open, the operating handle cannot be moved from the OFF to ON position without deliberately defeating the interlock mechanism. In the OFF position, the interlock can be defeated by pushing the interlock lever extension (**10**) downward while moving the handle to the ON position (Figure 2). With the enclosure door open and the handle in the ON position, the interlock can be defeated by turning the defeater screw (**11**) on the operating handle counterclockwise. When the enclosure door is closed, the door latch mechanism now automatically defeats the interlock.

C. Weld the door catch bracket (**12**) to the enclosure door. (Figures 2 and 4).

NOTE: Holes may be drilled in the door catch bracket using the projections as centers. *User must provide the mounting hardware.*

D. Fasten the door catch (**13**) to the door catch bracket with two #8-32 x 5/16 in. pan head screws and external tooth lockwashers (Figure 2).

INSTALLATION DIAGRAMS

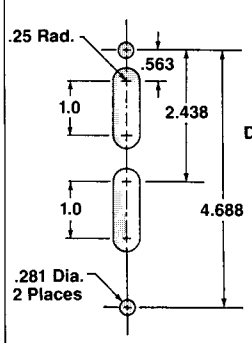


Figure 1

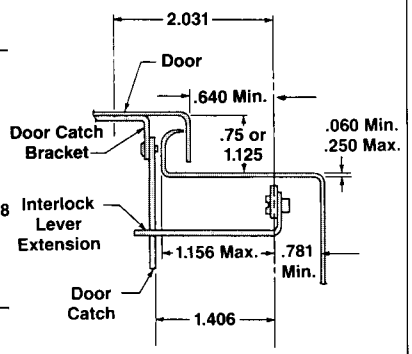


Figure 2

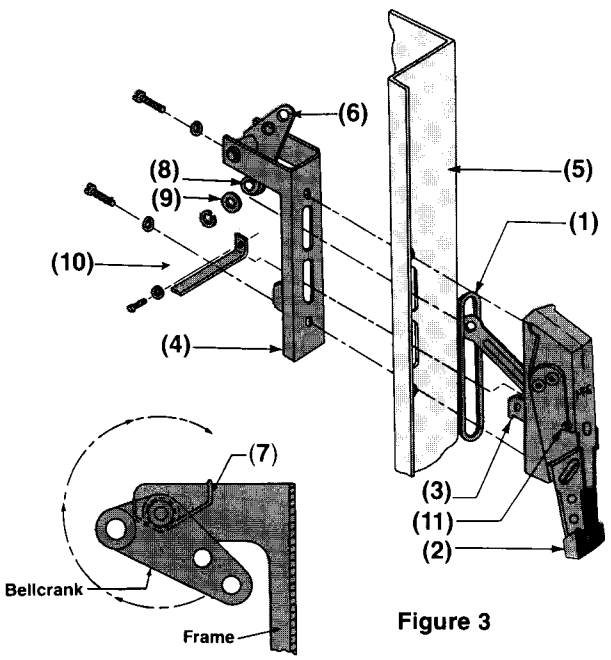


Figure 3

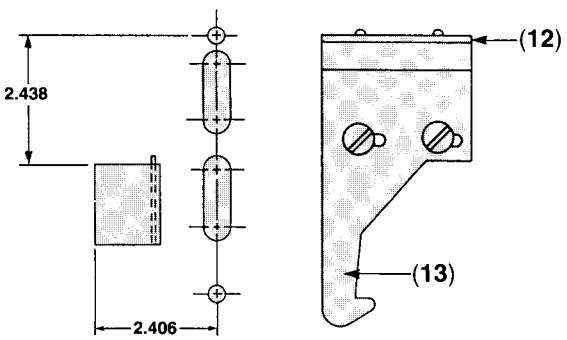


Figure 4

Assembly Instructions

Adjusting Door Catch Mechanism

A. Close the enclosure door and move the handle into the ON position. Adjust the door catch downward if the handle cannot be moved from the ON position.

B. With the handle in the ON position, try to open the enclosure door without turning the defeater screw in the handle. If the door opens, readjust the door catch and repeat Steps A and B.

Mounting Breaker Operator

The circuit breaker can be mounted remotely from the handle within a range that is limited by the length of the operating cable (**14**) (Figure 7) and the depth of the enclosure. Table 2 and Figure 5 show the horizontal range **E** of the circuit breaker in 8 to 30 in. enclosures.

Table 1 — Circuit Breaker Mounting Dimensions

Breaker Type	A	B	C	D	G	Tap Size
CED6, CED6-ETI	1.0	5.0	.65	8.93	3.25	#8-32
All Other Types	1.0	5.0	.65	6.33	—	#8-32

Table 2 — Maximum E Dimensions①

Cable	Enclosure Depth (Inches)							
	8"	10"	12"	16"	18"	20"	24"	30"
FHOECO36 (36")	13.8	13.5	13.0	10.7	8.7	5.3	—	—
FHOECO48 (48")	25.8	25.7	25.3	24.2	23.4	22.4	19.6	12.2

①Maximum E dimension only if F = 4.6.

Table 3 — F Dimensions

Enclosure Depth	36" Cable		48" Cable	
	Min.	Max.	Min.	Max.
8	-4.2	15.5	-16.0	27.0
10	-5.2	15.0	-16.5	27.0
12	-6.0	14.7	-17.0	26.8
16	-4.5	14.2	-16.5	26.5
18	-3.4	12.8	-16.0	25.5
20	0.6	10.0	-15.5	24.5
24	—	—	-14.0	22.5
30	—	—	-8.7	17.4

Caution: When installed, the cable bend radius should not be less than 3 in. This minimum wire bending requirement must be met to insure operating safety. The mounting procedure is as follows:

A. Determine the desired circuit breaker mounting location using Tables 1, 2 and Figure 5.

B. Drill and tap four mounting holes (**15**) in the enclosure back panel using dimensions **A** and **B** from Table 1.

C. Mount the circuit breaker inside the back panel. Align the holes in the panel with the mounting holes of the breaker.

D. Insert the three plastic spacers (**16**) into the circuit breaker mounting holes for support, as shown in Figure 6.

E. Install the operating mechanism (**17**) on the spacers (**16**) and secure with the three #¼-20 x 5 in. pan head screws and lockwashers. Insert the #¼-20 x 4¼ in. pan head screw through the hole without a spacer (**18**). Mount the circuit breaker and operating mechanism to the enclosure panel with the screws supplied.

Securing Operating Cable to Frame Assembly

A. To attach the operating cable (**14**) to the frame assembly (**4**), move the operating handle (**2**) to the ON position and attach the cable swivel (**19**) to the outer hole of the bellcrank (**6**). Secure the connection with an E Ring (Figure 7).

B. Secure the cable (**14**) to the frame assembly (**4**) by placing it between the cable retainer clip (**20**) and the shim (**21**), secure with two #10-32 x ⅜ in. screws and lockwashers. NOTE: Detent (**22**) in cable retainer must align with the groove (**23**) in the cable's metal fitting (Figure 7).

INSTALLATION DIAGRAMS

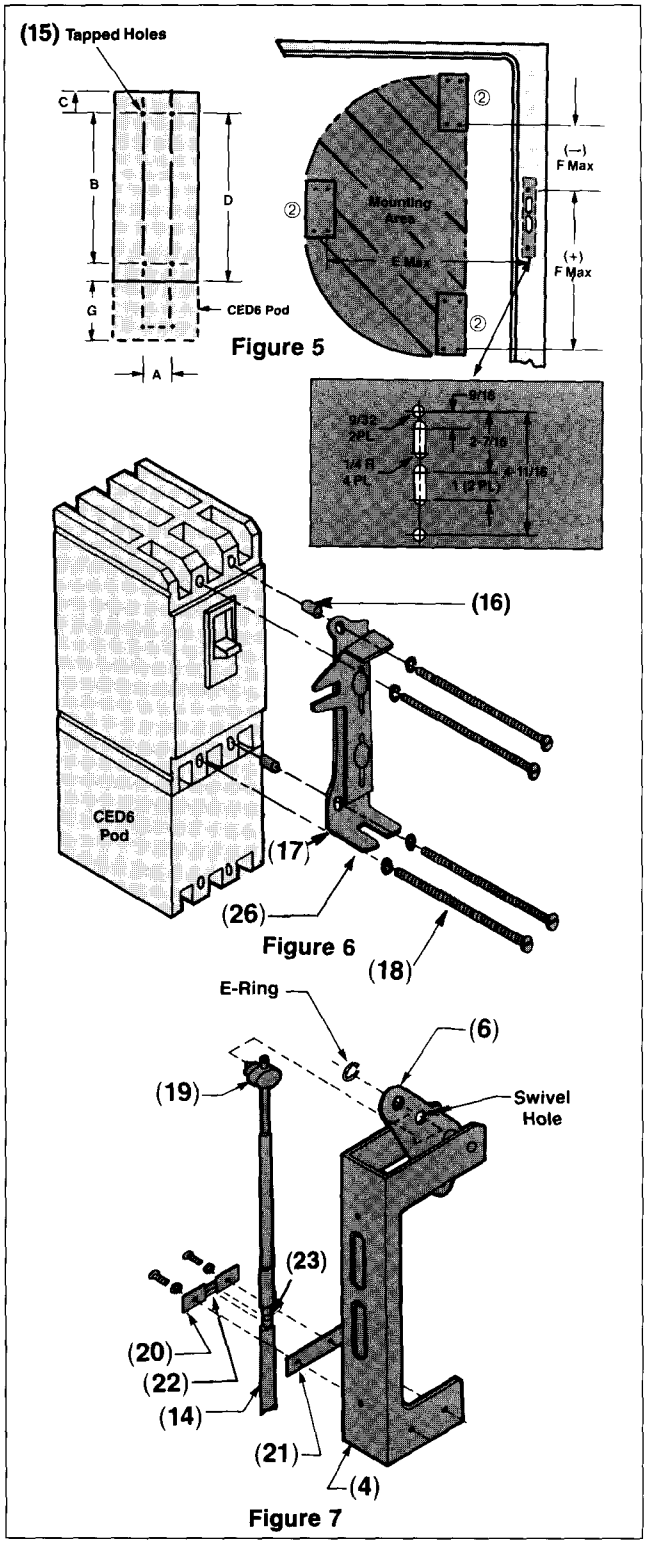


Figure 5

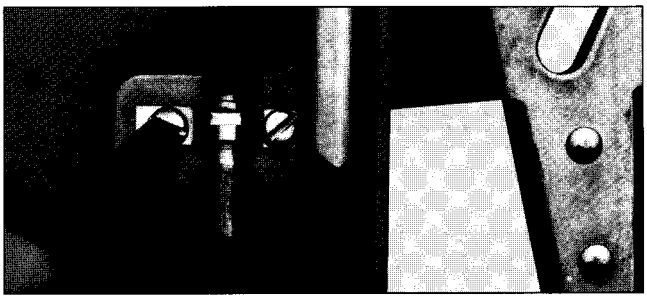
Figure 6

Figure 7

② Outlines represent breaker operator, not circuit breaker footprint.

I-T-E Max-Flex™ Flange-Mount Handle Operator

Types 1, 3, 3R, 4, 4X, 12



Tighten Detent Screws

Securing Operating Cable to Circuit Breaker

WARNING: Before attaching the cable to the circuit breaker, installers *must* confirm that the power from the supply source has been de-energized.

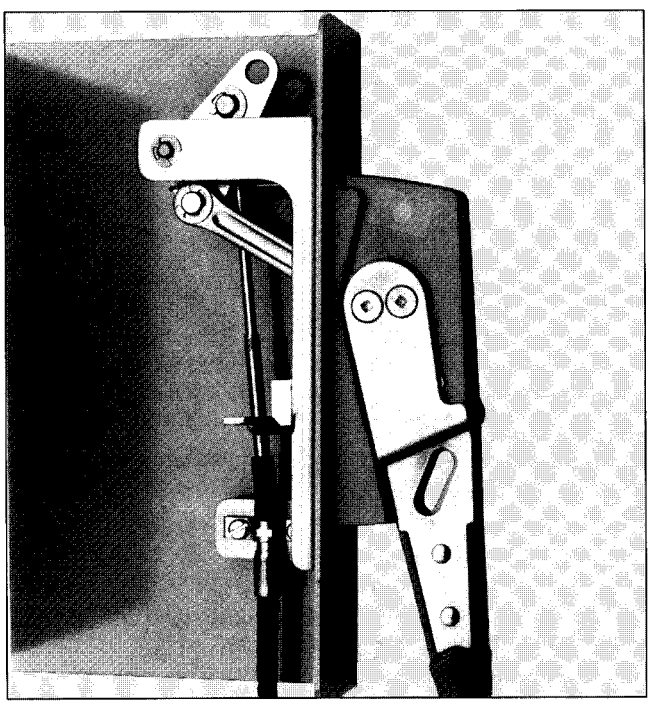
A. Move the circuit breaker handle to the ON position.

B. Remove the soft plastic cap from the end of the threaded cable rod (**24**) and slide the rod through the hole in the sliding plate tab (**25**) of the circuit breaker operating mechanism (**17**) (Figure 8).

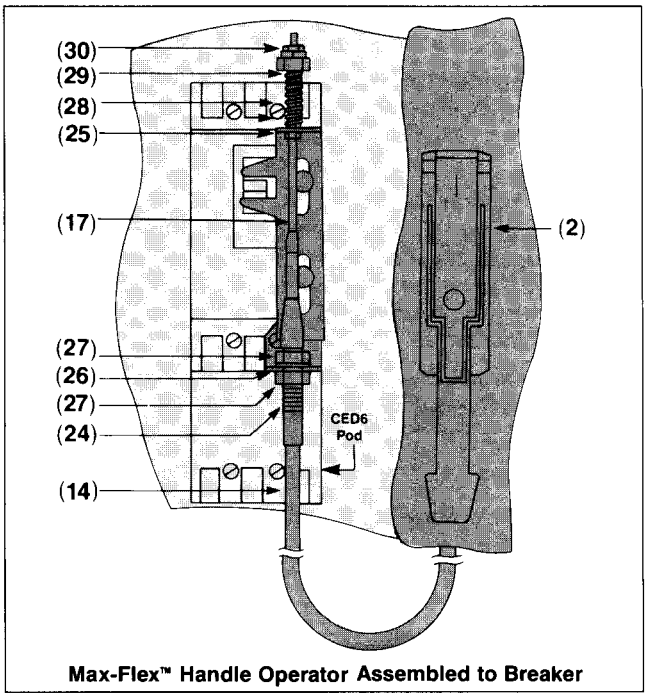
C. Move the flange mount operating handle (**2**) to its maximum ON position and hold it in place.

D. Place the cable mounting threads (**24**) into the slot on the fixed plate tab (**26**) so that the two mounting nuts (**27**) are on both sides of the tab. Adjust the two mounting nuts so that the #10-32 nut on the cable rod just touches the sliding plate tab (**25**). Tighten the mounting nuts (**27**) to secure the cable (Figure 8).

E. Continue holding the operating handle in the ON position and place the spring (**28**) over the end of the rod. Screw on the spring adjuster (**29**) and tighten until it begins to compress the spring. Do not overtighten.



Side View of Max-Flex™ Handle Operator



Max-Flex™ Handle Operator Assembled to Breaker

Figure 8

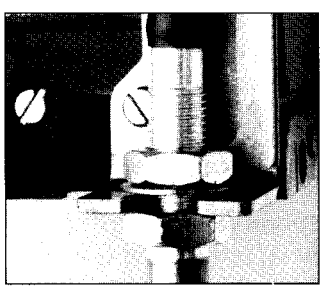
Making Cable Adjustments

A. Check that circuit breaker turns OFF and ON by moving the operating handle (**2**) up for ON and down for OFF. If the breaker does not switch ON, loosen the cable mounting nuts (**27**) at the fixed plate tab (**26**), hold the operating handle in the maximum ON position, and move the cable (**14**) toward the top of the breaker. Retighten the mounting nuts (**27**) to secure.

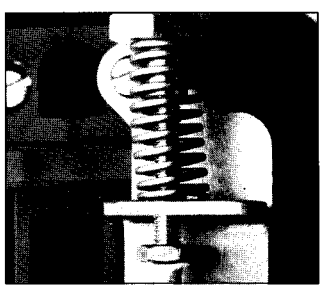
B. Trip the circuit breaker by pressing the PUSH TO TRIP button on the front of the circuit breaker.

C. Check that circuit breaker resets by moving the operating handle (**2**) from ON to OFF and back to ON. If the breaker resets, tighten the spring adjuster (**29**) one additional turn. Attach the lockwasher and #10-32 locknut to the end of the cable rod (**24**), and tighten the locknut.

D. If the circuit breaker does not reset after Step B, tighten the spring adjuster (**29**) one turn and repeat Step B. Continue this procedure until the breaker does reset, then tighten the adjuster spring one additional turn. Secure with the lockwasher and locknut (**30**).



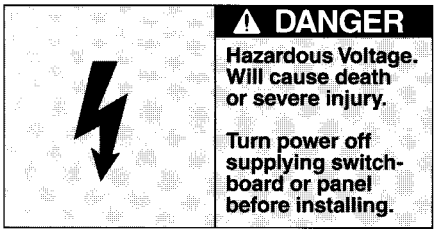
Fixed Plate Adjustment



Spring Adjustment

I-T-E Fixed-Depth Handle Operator

Types 1, 3, 3R, 4, 4X, 12



SAFETY INSTRUCTIONS

GENERAL INFORMATION

Description

The Fixed-Depth Handle Operator is designed to function with Siemens ED-Frame molded case circuit breakers and switches. A complete handle operator consists of a handle assembly, frame assembly, breaker operator assembly, adjustable door catch, and mounting hardware.

The operator features a trip indicator, the ability to padlock in the OFF position with up to three 5/16" padlocks, interlocks with I-T-E® DKR2, DKR3, DKL2 and DKL3 door latch mechanisms, and auxiliary switch (HAS-1) can be attached to provide remote indication of handle position.

Preparation

1. Turn OFF and lock out all power that supplies the circuit breaker and other equipment within the enclosure before installing this device.
2. Prepare mounting holes in the enclosure flange and the enclosure panel. (See Table below for hole dimensions and illustrations, Figures 1 and 2.)

Breaker Type	A	B	C	D	E	Tap Size F
ED, HED	2.38	6.81	1.00	5.00	—	#8-32 UNC
CED	2.38	6.81	1.00	5.00	3.25	#8-32 UNC

NOTE: All dimensions shown in inches.

Catalog Numbers	Fixed-Depth Handle Operators To Be Used With Following Breakers②
FDFBER FDFBEL FDFBER4① FDFBEL4①	ED2, ED4, ED6, HED4, HED6, HHED6, CED6, ED6-ET1, CED6-ET1

① Catalog numbers with the suffix "4" are for installation in Types 1, 3, 3R, 4, 4X and 12 enclosures. Catalog numbers without the suffix "4" are for installation in Types 1, 3, 3R and 12 enclosures.
② Fixed-Depth operators can only be installed on 3-Pole ED, HED and CED type circuit breakers.

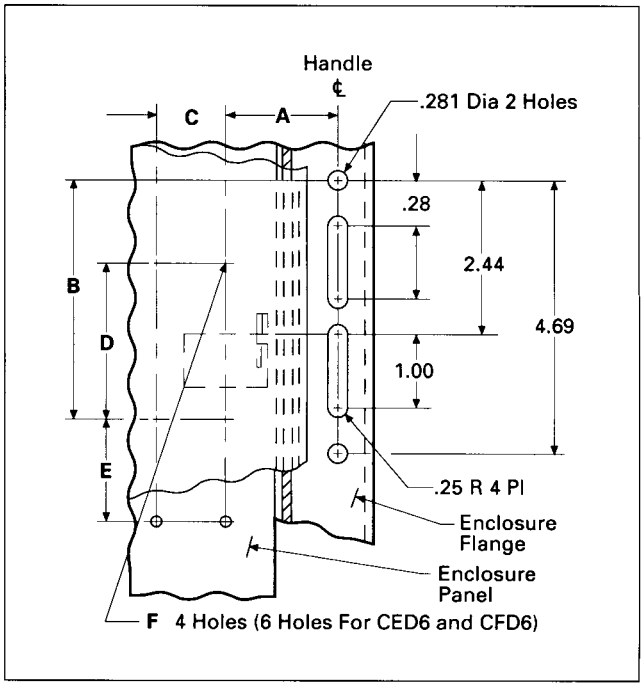


Figure 1

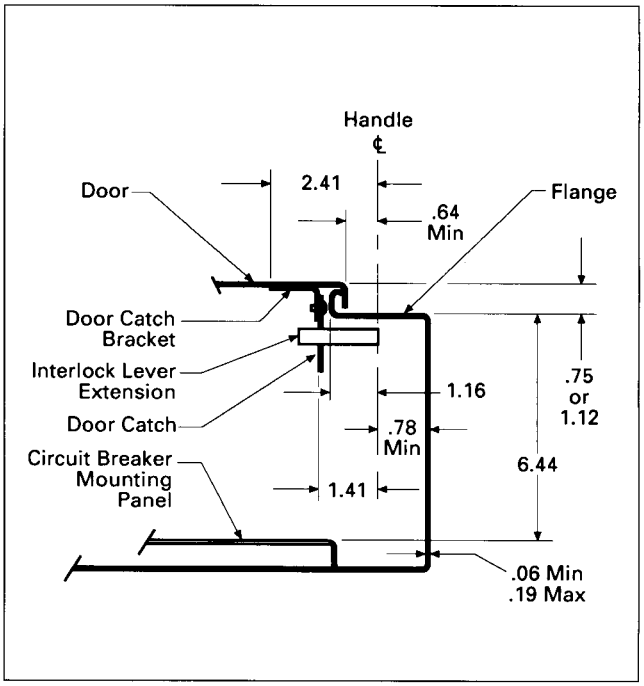


Figure 2

I-T-E Fixed-Depth Handle Operator

Types 1, 3, 3R, 4, 4X, 12

Installing Handle And Frame Assemblies (Figure 3)

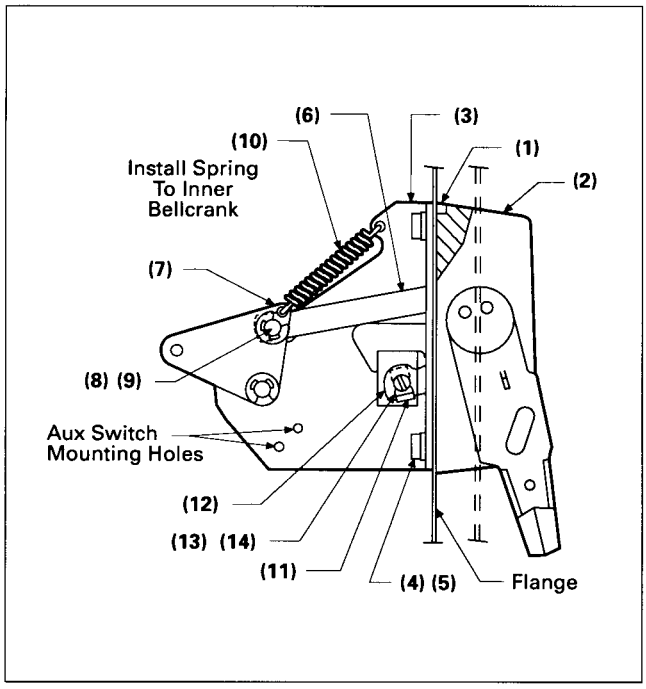


Figure 3

1. Secure gasket **(1)** into groove of handle assembly **(2)**. Mount handle assembly **(2)** and frame assembly **(3)** to enclosure flange using two 1/4-20 x 3/4 in. socket head cap screws **(4)** and 1/4 in. lockwashers **(5)**. Tighten screws **(4)** to 75 in.-lb.
2. Attach link **(6)** to bellcrank **(7)** using the 5/16 dia. x 5/8 in. grooved pin **(8)**. Secure pin **(8)** using the two 5/16 in. E-type retaining rings **(9)**.
3. (Catalog numbers FDFBER**(4)** and FDFBEL**(4)** only) Attach extension spring **(10)** to frame **(3)** and to inner bellcrank **(7)**.
4. Attach the interlock lever extension **(11)** to the interlock lever **(12)** and secure with #8-32 x 3/8 in. screw **(13)** and #8 helical lockwasher **(14)**. Tighten screw to 25 in.-lb.

Installing Door Catch (If Required) (Figure 4)

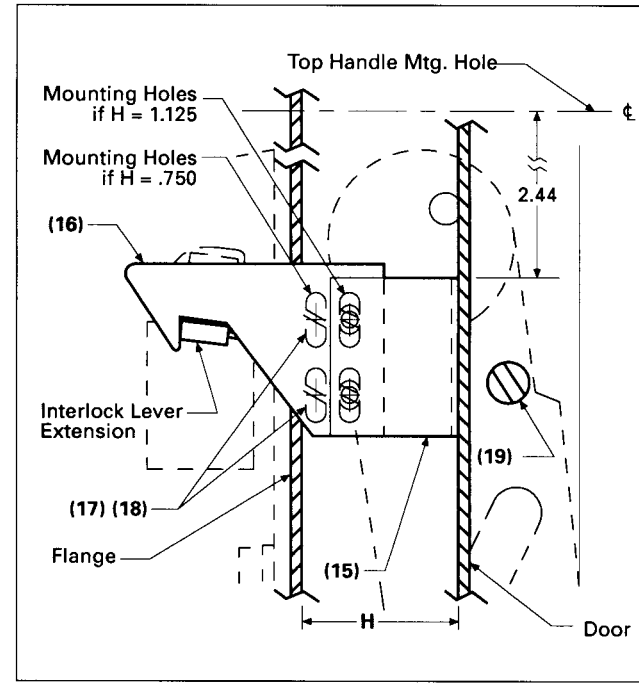


Figure 4

1. If no door catch is provided with the enclosure, weld the supplied door catch bracket **(15)** to the enclosure door and attach the adjustable door catch **(16)** to the door catch bracket **(15)** using the #8-32 x 5/16 in. mounting screws **(17)** and #8 external tooth lockwashers **(18)**. Note the "H" dimension for the correct mounting holes. Tighten the mounting screws to 25 in.-lbs.

Adjusting Door Catch (Figure 4)

1. Move the handle to the OFF position and close the enclosure door. This action should release the interlock, allowing the handle to be turned ON. If the handle cannot be turned ON, loosen the screws **(17)** and adjust the door catch **(16)** downward in its slot, retighten the screws **(17)** and repeat.
2. Move the handle to the ON position and attempt to open the enclosure door. The door catch **(16)** should engage the interlock lever extension and hold the door closed. If the door can be opened, adjust the door catch **(16)** downward.
3. Repeat steps 1 and 2 to insure that the handle cannot be turned ON unless the door is fully closed and the door cannot be opened if the handle is in the ON position.

NOTE: The door can be opened when the handle is in the ON position by rotating the interlock defeater screw **(19)** located on either side of the handle housing.

I-T-E Fixed-Depth Handle Operator

Types 1, 3, 3R, 4, 4X, 12

Installing Breaker And Breaker Operator (Figures 5 And 6)

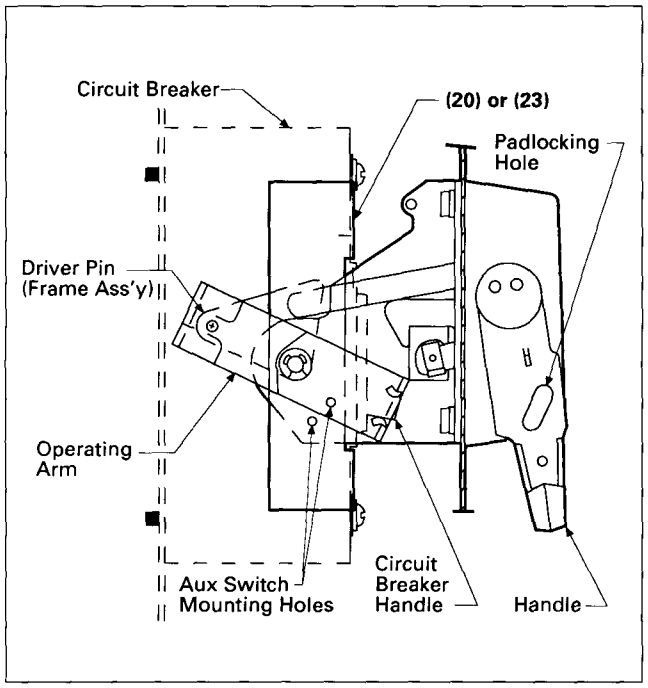


Figure 5

1. Move the operating handle and circuit breaker handle to the OFF position.
2. Locate the circuit breaker over the mounting holes in the enclosure panel and position the breaker operator **(20)** or **(23)** onto the circuit breaker, positioning the combination so that the operating arm engages the circuit breaker handle and the driver pin on the bell crank of the frame assembly.
3. Proceed with specific ED-frame instructions as follows:

   Secure the breaker and breaker operator **(20)** to the enclosure panel using the four #8-32 x four 3/8 in. screws **(21)**, four #8 lockwashers **(22)**, and two spacers (spacers supplied with separate instructions). Tighten the screws to 16 to 18 in.-lbs.

Adjusting The Breaker Operator (Figure 6)

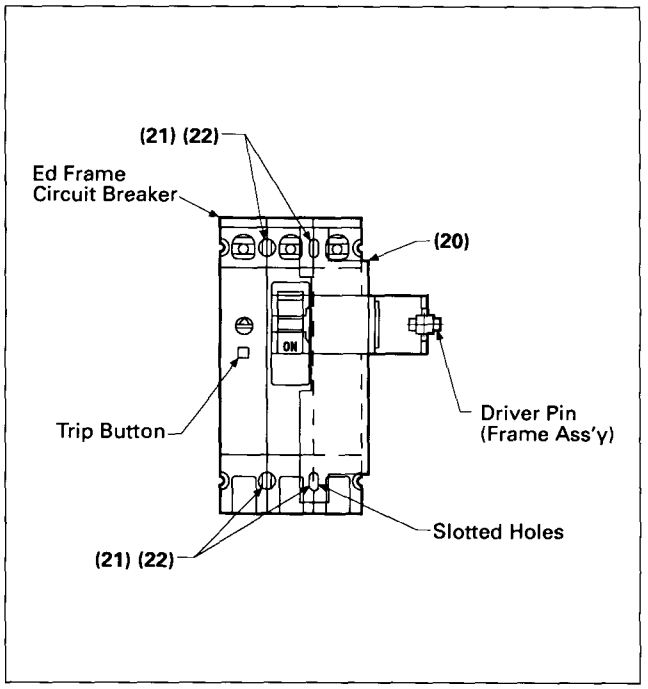


Figure 6

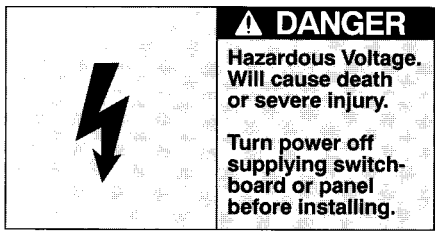
Adjusting The Breaker Operator (Figure 6)

1. Check that the circuit breaker turns ON and OFF by moving the operating handle UP for ON and DOWN for OFF. If the breaker does not turn ON, loosen the mounting screws, **(21)** or **(24)** and adjust the breaker operator upward 1/16 inch, tighten the mounting screws to 16 to 18 in.-lbs. and check if the breaker turns ON. Repeat if required.
2. To check the TRIP–RESET function, move the handle to the ON position and push the TRIP button located on the front of the circuit breaker. The circuit breaker will TRIP and the operating handle will move to an intermediate TRIP position. Move the operating handle from TRIP position to OFF and back to ON. The circuit breaker should RESET then turn ON. If the breaker does not RESET, loosen the breaker operator mounting screws **(21)** or **(24)** and adjust the breaker operator downward 1/16 inch and retighten the screws per step 5. Repeat if required.

Padlocking (Figure 5)

Move the handle to OFF position and attach padlock(s) at the indicated padlocking hole.

I-T-E Door Latch Mechanism (DKR2, DKR3, DKL2, DKL3)①



⚠ SAFETY INSTRUCTIONS

GENERAL INFORMATION

Description

These door latch mechanisms are for use in standard or custom built enclosures. The door latch post assemblies and the door catch are supplied with the kits. *Users must supply their own ¼ in. x ½ in. steel latch bar.* Enclosures with an overall height less than 40 in. require the two-point door latch mechanism. When the overall height is greater than 40 in., the three-point latch mechanism is used.

The door latch mechanism can be used with or without the type FHOH Flange Mount Handle Operator. These instructions apply when the door latch mechanism is mounted adjacent to and interlocks with the FHOH Handle Operator. The door handle can be padlocked to prevent unauthorized entry into the enclosure. Drawings in these installation instructions are oriented for right-hand flange installation. Left-hand flange installation drawings are mirror images of the right-hand versions. For left-hand flange installation, substitute "clockwise" for "counterclockwise" and vice versa, whenever those words appear.

Installation of the Door Latch Mechanism

A. Drill mounting holes in the enclosure door observing the minimum dimensions shown in Figure 2. See FHOH Handle Operator instructions for flange drilling pattern.

NOTE: **D** and **E** dimensions are determined by the height of the enclosure.

Refer to Figure 1 for the following steps:

B. Place gasket (**1**) on handle plate (**2**) and attach handle plate to enclosure door with two thin wall hex nuts (**3**). Tighten the nuts to 100 in. lb.

C. Insert lockout screw (**4**) and handle (**5**) through holes in the handle plate.

D. Install latch bar post assembly (**6**) (screw, sealing washer, flat washer, and special hex nut (**7**), if used.)

E. Attach top (**8**), bottom (**9**) and latch plate rollers (**10**) to latch bar with retaining pins and E-rings.

NOTE: Two-point latch does not have bottom roller.

F. Fasten the top and bottom rollers to the enclosure door with locking type flange nuts. Tighten the nuts, then loosen them ⅛ turn to allow movement of the roller assemblies.

G. Place bottom spring (**11**) over the bottom thin wall hex nut inside the enclosure door.

H. Turn the handle ¼ turn clockwise (looking from inside the enclosure door) and attach the latch plate roller to the handle shaft, while inserting the bent leg of the spring into the hole in the latch plate. Fasten with a locking-type flange nut. Tighten the nut, then loosen ⅛ turn to allow movement of the roller assemblies (Figure 1).

NOTE: Straight leg of spring must rest against pin (**12**) on handle plate. See inset on Figure 1.

I. Place top spring (**13**) over top thin wall hex nut. Attach lockout plate (**14**) to lockout screw using locking type flange nut. Tighten flange nut. Insert bent leg of spring into hole in lockout plate as shown in Figure 1 detail.

J. Attach the interlock defeater lever (**15**) to the latch bar (**16**) with two #10 lockwashers and #10-24 screws.

NOTE: The position of lever depends on enclosure depth (Figure 3).

K. Weld or rivet the door catch (**17**) to the enclosure door. User must supply the mounting hardware.

L. Attach the door latch label to the door handle on the enclosure door.

Adjusting the Mechanism

If using in conjunction with the FHOH or FHOH4 Handle Operator, perform the following steps:

A. With the door in the open (unlatched) position, close the door, but do not turn the door handle. The lockout plate should latch the door partially closed.

B. Turn the handle clockwise to stop. This will engage the rollers against the enclosure flange, securing the door fully closed.

C. Check that the circuit breaker can be turned ON. If the breaker will not turn ON, adjust the interlock defeater lever downward to engage the lever on the handle operator.

D. To open the door, insert a screwdriver into the handle screw and turn the screw and handle counterclockwise. The door will only open partially if the operating handle is in the ON position. If the door fully opens with the handle in the ON position, adjust the interlock defeater lever upward and repeat Steps C and D.

NOTE: To open the door when the handle is in the ON position, turn the latch defeaterr screw located on the side of the operating handle.

Minimum Dimensions (In Inches)

C	1.922	**Q**	2.594
H	9.375	**R**	1.875
I	.50	**S**	1.625
J	2.688	**T**	250
K	1.859	**U**	.688
L	1.797	**V**	.281 Dia.
M	.391 Dia.	**W**	.703 Dia.
N	2.297	**X**	2.484
P	.719	**Y**	.219 Dia.

①The last letter and number designate right- or left-hand, 2 or 3 point latches.

Installation Diagrams

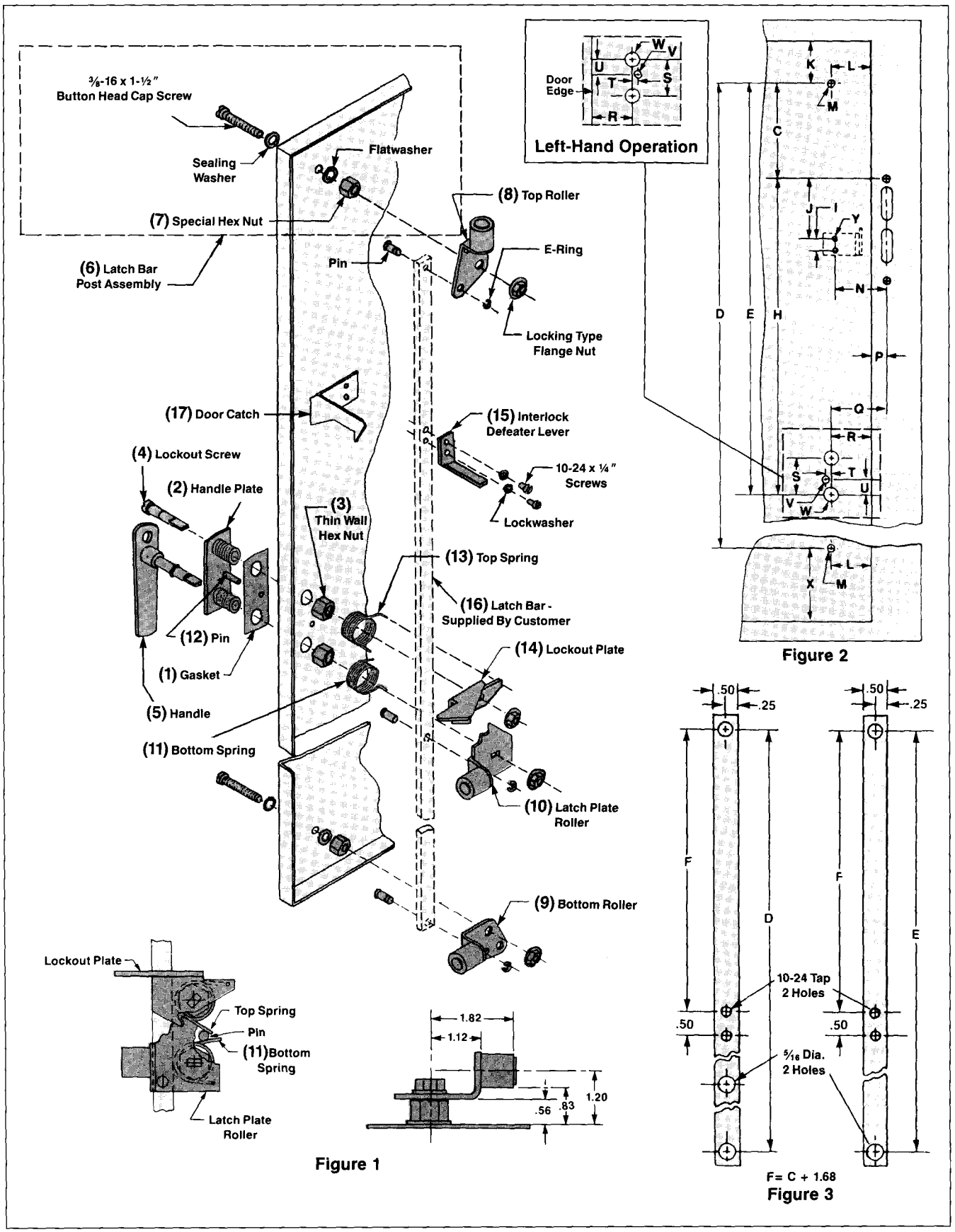


Figure 1

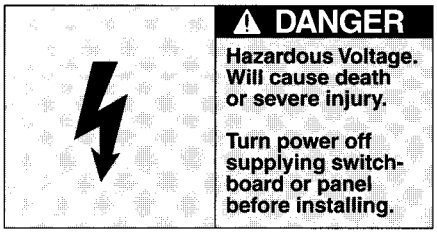
Figure 2

F= C + 1.68

Figure 3

I-T-E TELEMAND® Electric Motor Operator

Catalog Numbers MOE6120, MOE6240



SAFETY INSTRUCTIONS

INSTALLATION INSTRUCTIONS

Description

The motor operated mechanism is designed to open, close and reset a circuit breaker or switch by remote control. The customer must supply the circuit breaker or switch, normally ON and OFF pushbuttons, external wiring, a control power source, and all control logic. Consult the wiring diagram (Figure 3) for a typical control connection.

The motor operator is hinged for opening to the bottom (or load end of the breaker). see Figure 2.

NOTE: For Automatic Reset Operation a separate auxiliary contact must be provided by the customer.

Installation

1. Turn off and lock out all power supplying circuit breaker and motor operator before installation or servicing.
2. Mount the breaker and motor operator (with its cover open) together on the mounting panel as shown in Figure 2.
3. The 4 spacers are placed between the breaker and the motor operator mounting base plate.
4. The motor operator is aligned on top of the spacers and the (4) 8-32 screws and installed as shown in Figure 2.
5. Rotate cam to the off position. See label inside motor operator.
6. Close and latch the mechanism cover.
7. Complete the desired control connections and electrically test the motor operator system before reenergizing the breaker power terminals in accordance with the electrical operation.

Motor Operator	Frames	For Use With: I-T-E® Circuit Breakers And Switchtypes
MOE6120 MOE6240	ED	ED2, ED4, ED6, HED4 HED6, CED6, ED6-A, CED6-A

Electrical Operation

With the breaker and the operating mechanism in the OFF position, press the ON button to energize the motor. This action will close the breaker. When the breaker handle reaches the ON position, the motor circuit is disconnected by an internal limit switch.

Electrical Characteristics Table

	ON			OFF			
Catalog No.	In-Rush Amps	Running Amps	Time Hz	In-Rush Amps	Running Amps	Time Hz	Reset Amps
MOE6120	10.25	2.3	33	10.0	2.0	24	18
MOE6240	5.25	1.1	33	10.0	2.0	24	18

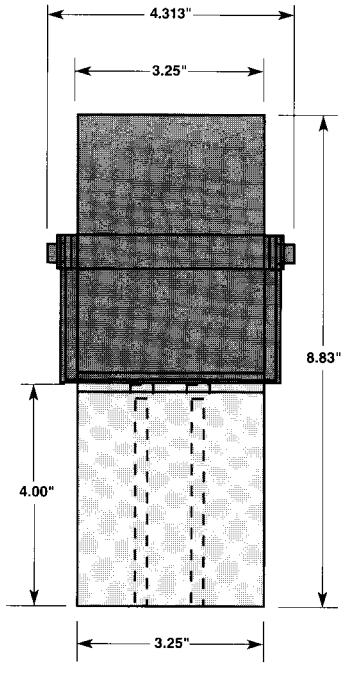
Closing or Opening Time: 0.6 seconds

With the breaker and the operating mechanism in the ON position, press the OFF button to energize the motor. This action will open the breaker. When the breaker handle reaches the OFF position, the motor circuit is disconnected by an internal limit switch.

When the circuit breaker trips automatically, there is no external indication that the breaker has tripped unless a separate bell alarm accessory (contact Siemens for appropriate catalog number) is provided to energize a customer furnished warning device. After the circuit breaker trips automatically, it is necessary to press the OFF button to move the breaker handle to the reset position.

Automatic Reset

For automatic reset, an auxiliary switch (Contact Siemens for appropriate Catalog Number) is used to return the breaker to the OFF/RESET position after it has been tripped. This auxiliary switch is mounted inside the breaker and wired in parallel with the OFF button. When the breaker trips, the auxiliary switch closes, thus energizing the motor circuit which moves the breaker to the OFF/RESET position.



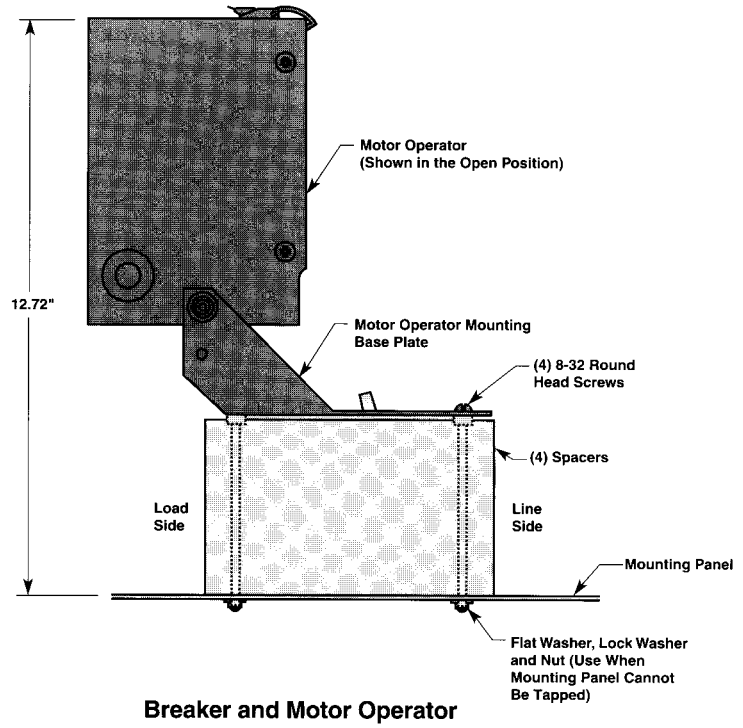
Bottom View

Figure 1

After the motor operated mechanism has reset the breaker, the motor operator internal limit switch opens the circuit. To provide automatic reset, the ON pushbutton must be a single pole double throw device and it must be wired per Figure 3.

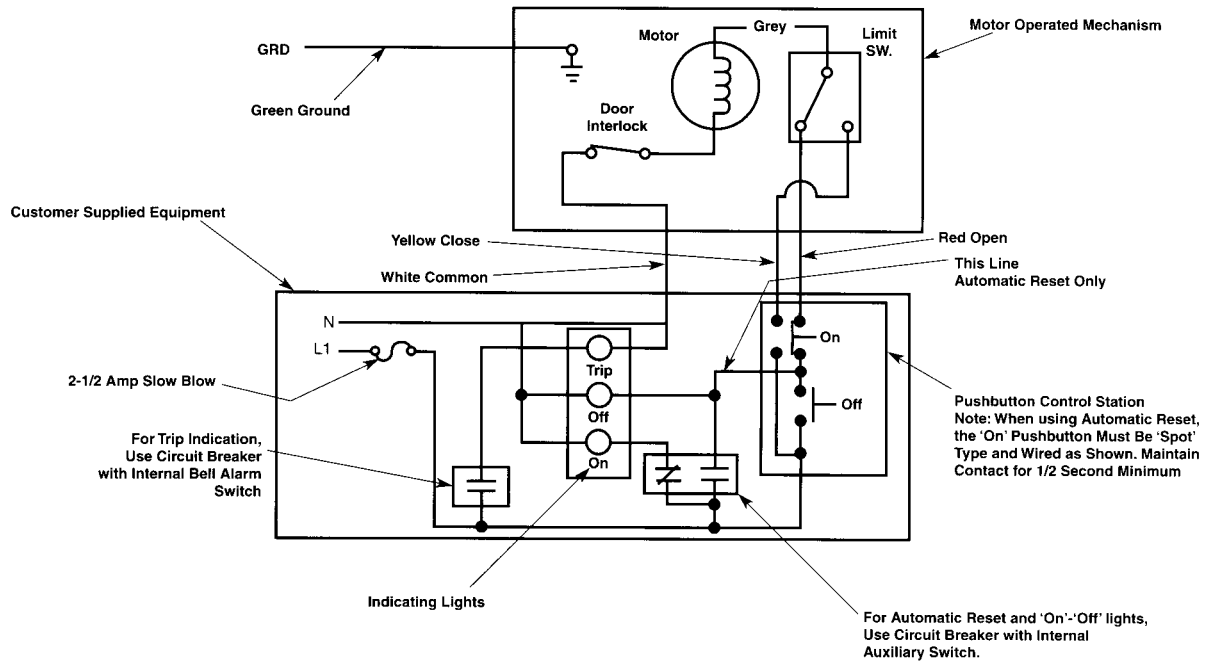
Manual Operation

Operate the cover latch and swing the hinged motor operator cover away from the breaker to expose the breaker handle. To return to electrical operation, rotate cam to a position that matches the breaker handle. See instruction label inside operator.



Breaker and Motor Operator

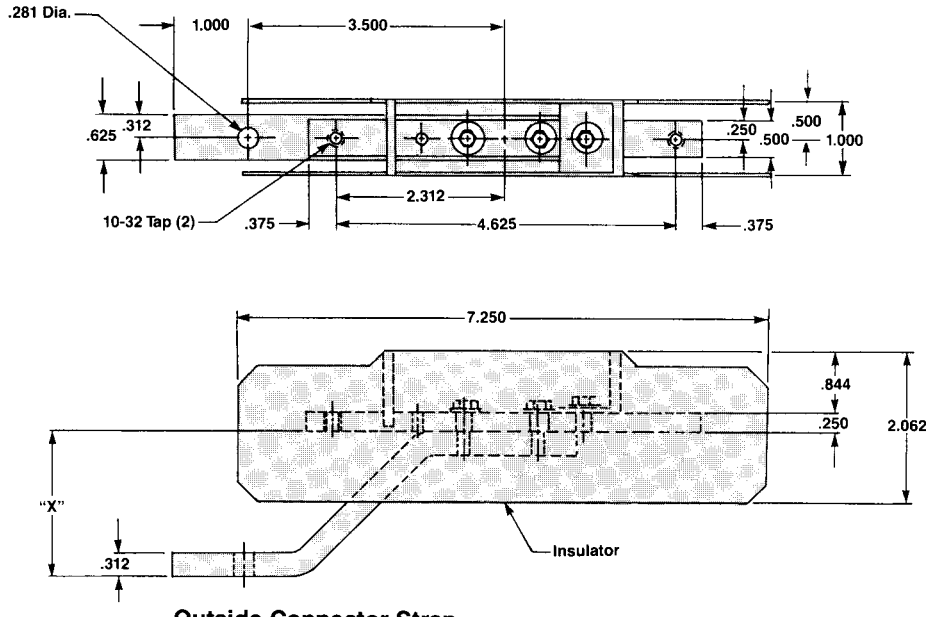
Figure 2



Wiring Diagram Motor-Operated Mechanism
(All Switch Contacts Shown with Circuit Breaker in the ON Position)

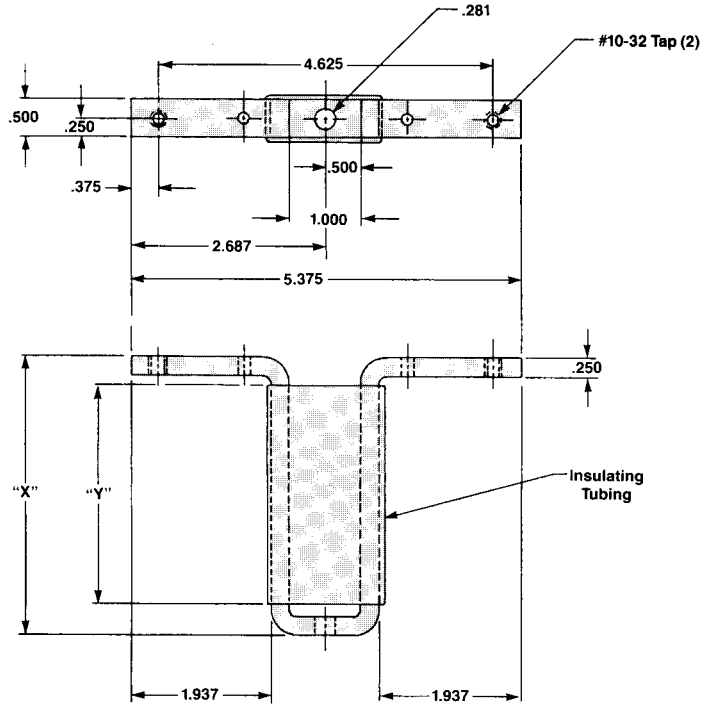
Figure 3

I-T-E Panelboard Connector Straps①



Outside Connector Strap

Catalog Number	X
CS3600R	1.984
CS3602R	3.546



Inside Connector Strap

Catalog Number	X	Y
CS3601R	2.234	1.5
CS3603R	3.796	3.0

①These straps are not used in series 6 or 7 panelboards.

I-T-E Single Pole Mounting Bracket (E2BMB)①

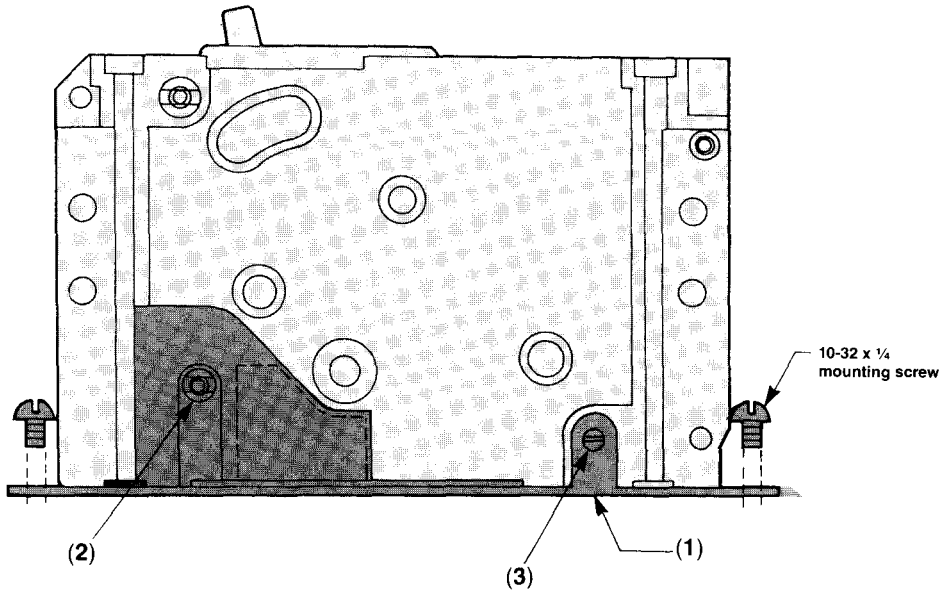
A. Place short tab (**1**) in circuit breaker case slot and then slide both tabs toward matching holes in side of circuit breaker case (Figure 1).

B. Long tab (**2**) must be snapped into place. (It can be removed by prying up with screwdriver and sliding it off.)

C. Fasten mounting bracket to circuit breaker with self-tapping screw (**3**) provided (6 in. lb. max. torque).

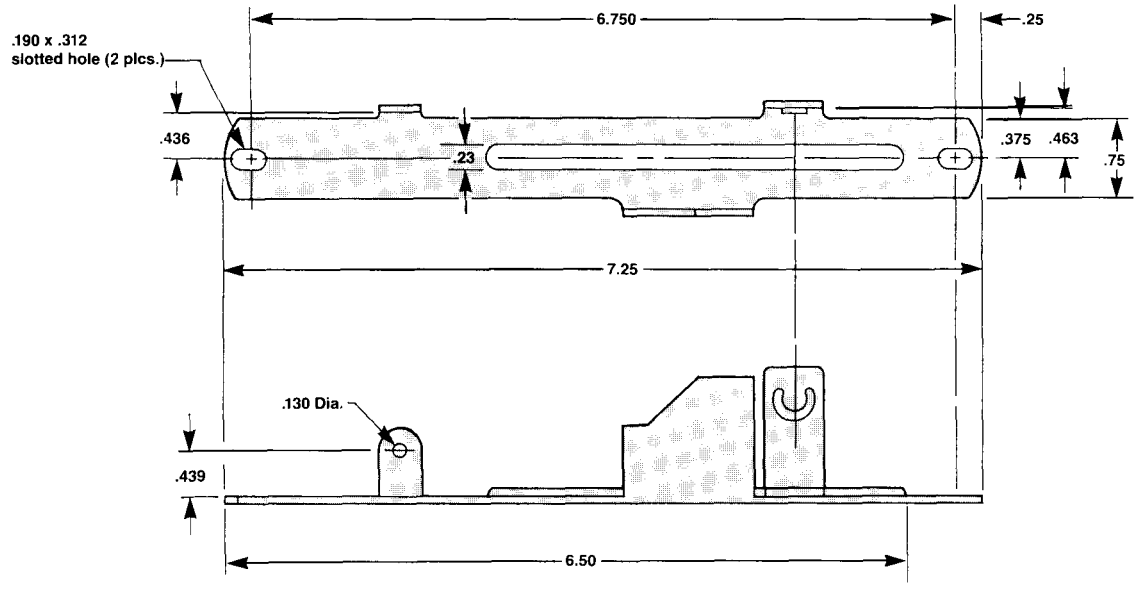
D. Mount breaker to enclosure surface with two #10-32 x ¼ in. mounting screws provided.

① This bracket is used for single pole mounting with or without accessory module.



Installation Diagram

Figure 1



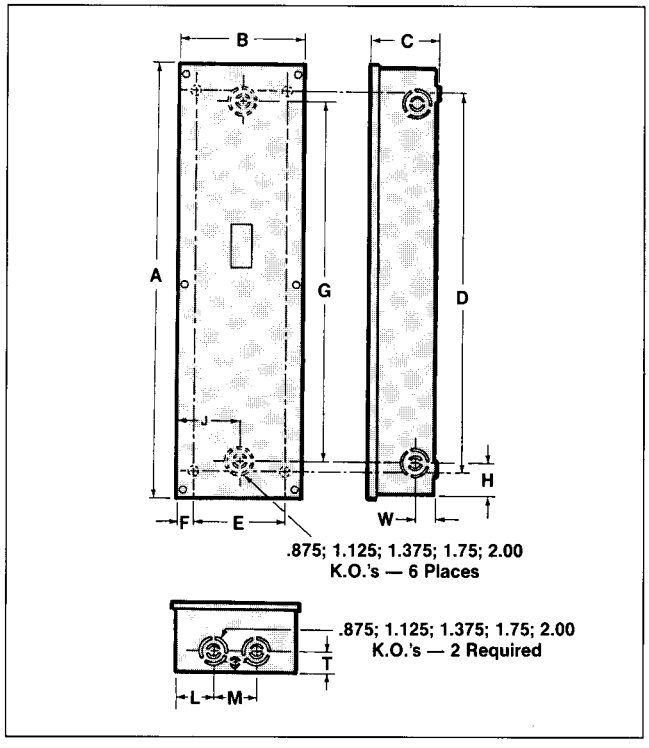
Installation Dimensions

Figure 2

Types 1, 3R, 4, 4x

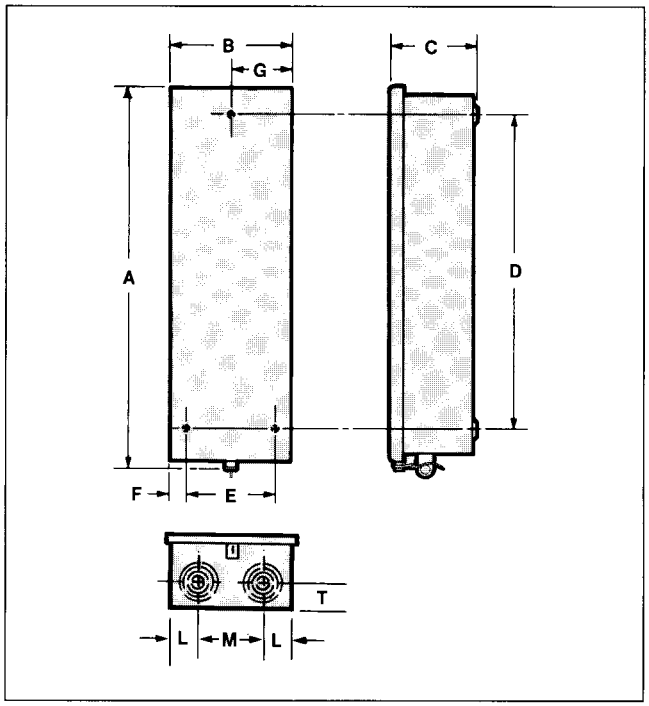
Type 1—E2N1S①②, E2N1F①②, CLE6N1S①③, CLE6NIF①③

General purpose indoor, sheet-steel enclosure for use in normal atmosphere, listed as service-entrance equipment.



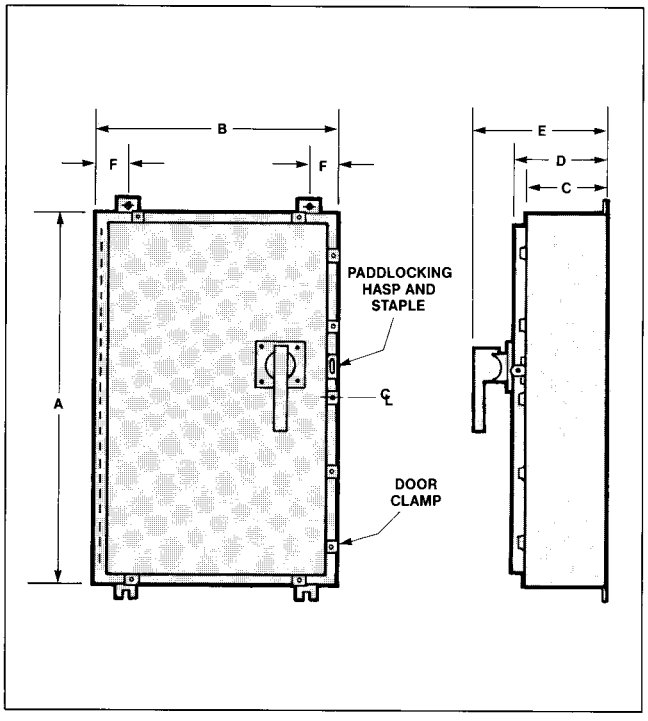
Type 3R—E2N3R②, CLE6N3R③

An outdoor sheet-steel enclosure providing protection against driving rain, sleet or snow. Listed as service-entrance equipment.



Type 4, 4X—ED6SS4②

Stainless steel indoor or outdoor enclosure designed for use in areas where serious corrosion problems exist. Meets NEMA Type 3, 4, 4X, 12 and 13 requirements and UL 508 Type 4 and 4X requirements.



Dimension (In Inches)

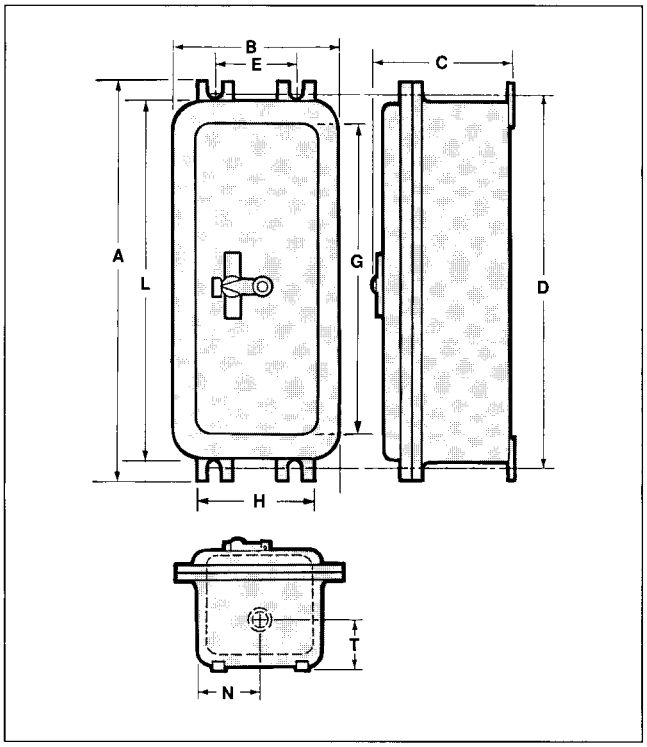
Ref.	Catalog Number						
	E2N1S	E2N1F	CLE6N1S	CLE6N1F	E2N3R	CLE6N3R	ED6SS4
A	16.7	17.5	21.47	22.25	17.56	22.3	20.0
B	7.5	8.5	7.6	8.5	7.25	7.25	16.0
C	5.06	5.06	5.11	5.11	5.25	5.25	6.0
D	13.7	13.7	18.25	18.25	12.6	17.4	7.2
E	5.25	5.25	5.25	5.25	5.25	5.25	9.75
F	1.0	1.0	1.0	1.0	1.0	1.0	3.0
G	13.2	13.2	18.3	18.3	3.625	3.625	—
H	1.6	1.6	1.6	1.6	—	—	—
J	3.6	3.6	3.6	3.6	—	—	—
L	2.1	2.1	2.1	2.1	1.5	1.5	—
M	3.1	3.1	3.1	3.1	4.25	4.25	—
T	2.2	2.2	2.2	2.2	1.56	1.56	—
W	1.6	1.6	1.6	1.6	—	—	—

①"S" suffix is for surface mounted, "F" suffix is for flush mounted.
②For use with circuit breaker types ED2, ED4, ED6, HED4, HED6.
③For use with circuit breaker type CED6.
NOTE: Neutral supplied with each enclosure.

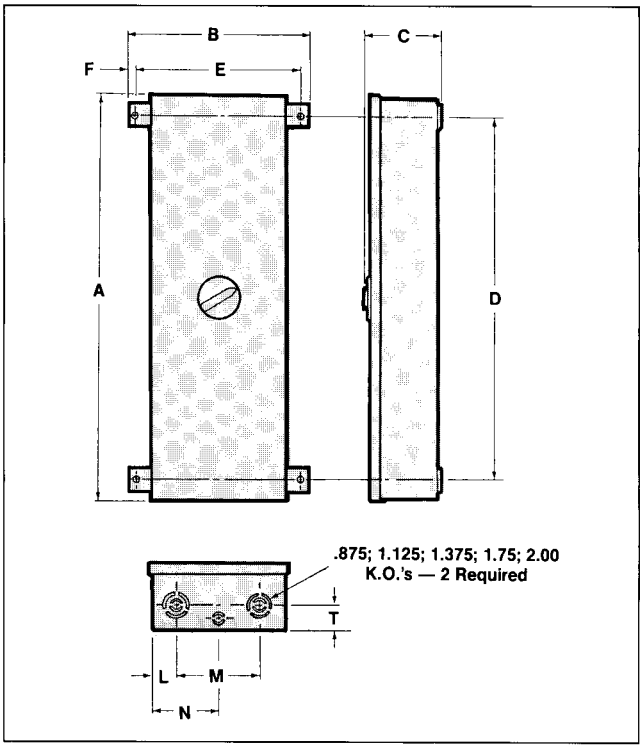
Types 7, 9, 12

Type 7, 9—EA (60A)①, EB (100A)①

Cast aluminum enclosure, classified as explosion and fire hazard only enclosure for use in hazardous locations; Class I—Group D, Class II—Groups E, F and G, Class III.

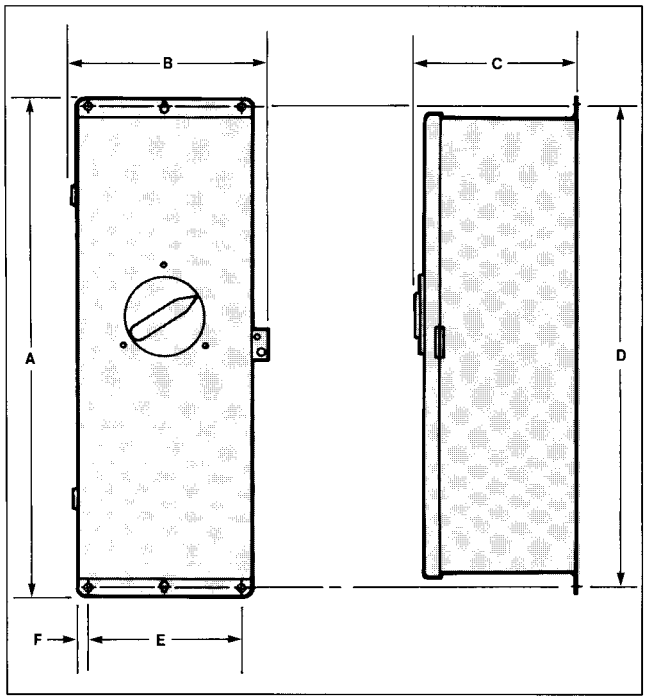


Type 12, 12K—CLE6N12②, CLE6N12K②③



Type 12, 12K—E2N12(K)①

A special-industry, sheet-steel enclosure for indoor use in atmosphere containing particles of lint, dust, dirt, sawdust and other foreign matter.



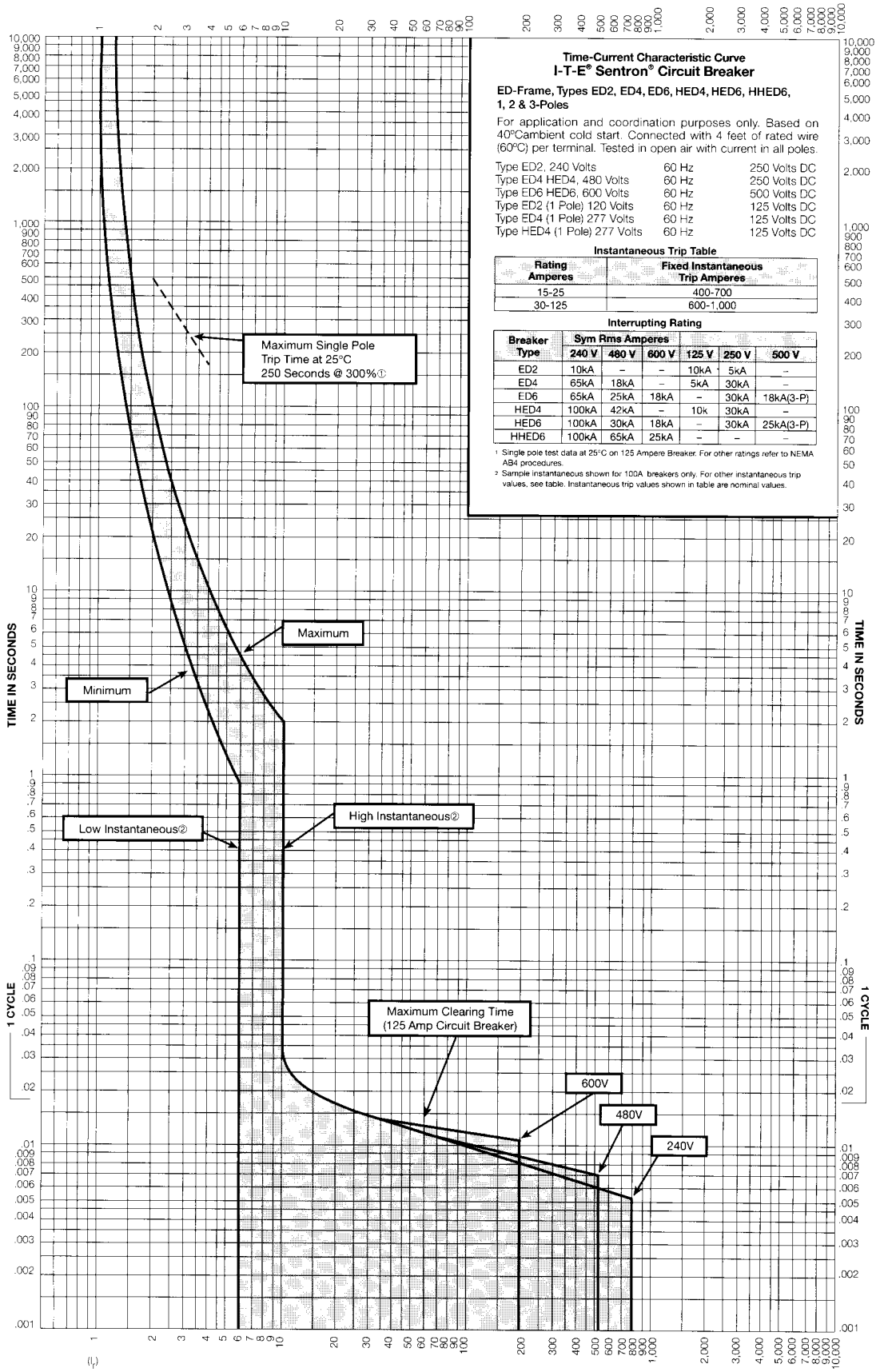
Dimensions (In Inches)

Ref.	Catalog Number			
	EA (60A)	EB (100A)	E2N12K	CLE6N12K
A	14.3	19.4	18.6	22.6
B	9.4	9.9	7.5	8.3
C	6.6	6.7	5.8	7.06
D	13.1	18.0	16.75	22.0
E	5.5	6.0	6.06	6.06
F	—	—	.5	.5
G	10.75	16.0	—	—
H	5.1	6.5	—	—
L	14.25	19.4	—	2.0
M	—	—	—	3.1
N	4.7	4.95	—	4.15
T	1.6	2.0	—	2.4

①For use with circuit breaker types ED2, ED4, ED6, HED4, HED6.
②For use with circuit breaker type CED6.
③Add "K" suffix when Type 12 with knockouts is required.
NOTE: Neutral supplied with each enclosure.

ED-Frame Time Current Curve

Types ED2, ED4, ED6, HED4, HED6, HHED6



Time-Current Characteristic Curve
I-T-E® Sentron® Circuit Breaker

ED-Frame, Types ED2, ED4, ED6, HED4, HED6, HHED6, 1, 2 & 3-Poles

For application and coordination purposes only. Based on 40°Cambient cold start. Connected with 4 feet of rated wire (60°C) per terminal. Tested in open air with current in all poles.

Type ED2, 240 Volts	60 Hz	250 Volts DC
Type ED4 HED4, 480 Volts	60 Hz	250 Volts DC
Type ED6 HED6, 600 Volts	60 Hz	500 Volts DC
Type ED2 (1 Pole) 120 Volts	60 Hz	125 Volts DC
Type ED4 (1 Pole) 277 Volts	60 Hz	125 Volts DC
Type HED4 (1 Pole) 277 Volts	60 Hz	125 Volts DC

Instantaneous Trip Table

Rating Amperes	Fixed Instantaneous Trip Amperes
15-25	400-700
30-125	600-1,000

Interrupting Rating

Breaker Type	Sym Rms Amperes					
	240 V	480 V	600 V	125 V	250 V	500 V
ED2	10kA	–	–	10kA	5kA	–
ED4	65kA	18kA	–	5kA	30kA	–
ED6	65kA	25kA	18kA	–	30kA	18kA(3-P)
HED4	100kA	42kA	–	10k	30kA	–
HED6	100kA	30kA	18kA	–	30kA	25kA(3-P)
HHED6	100kA	65kA	25kA	–	–	–

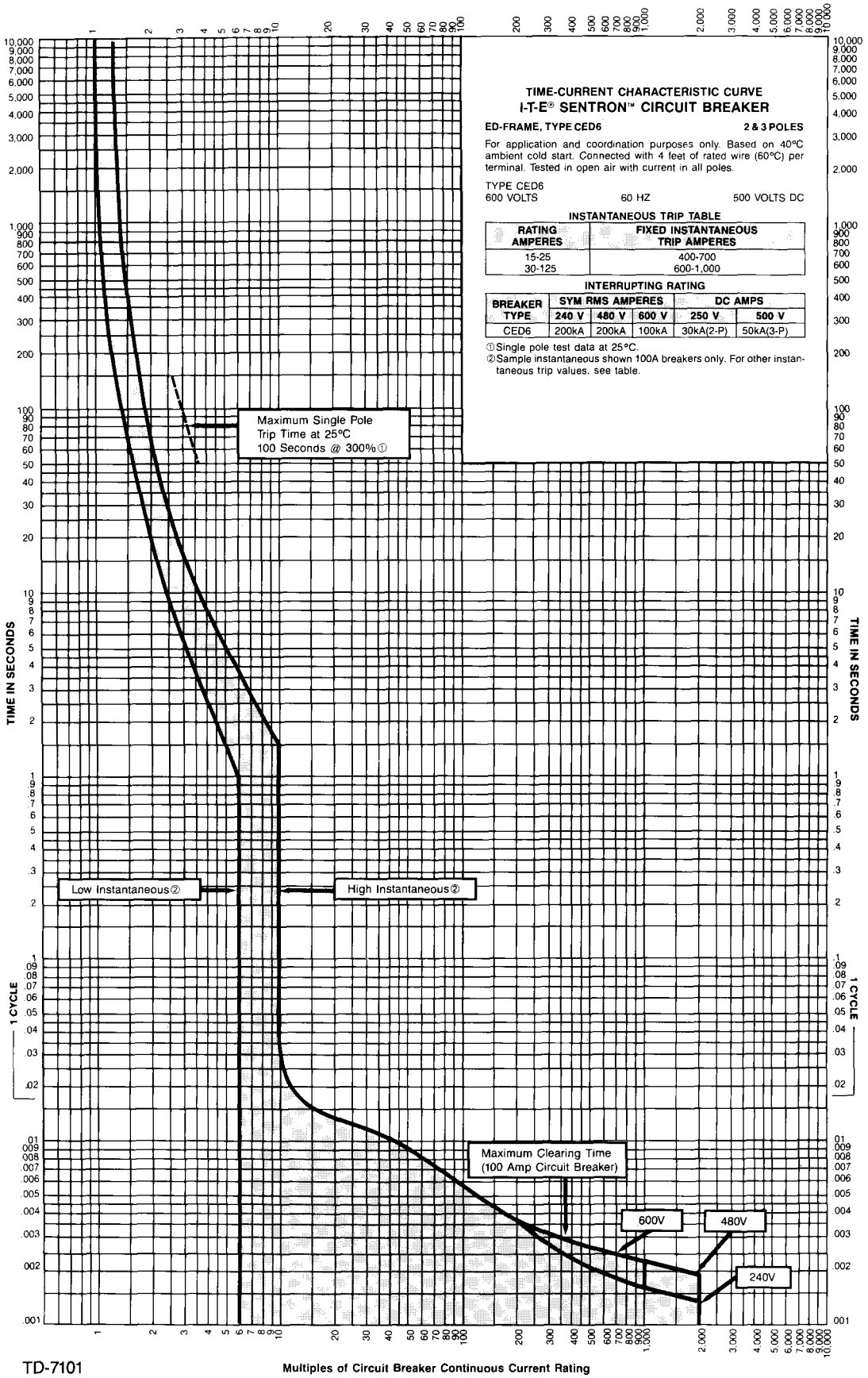
1 Single pole test data at 25°C on 125 Ampere Breaker. For other ratings refer to NEMA AB4 procedures.

2 Sample instantaneous shown for 100A breakers only. For other instantaneous trip values, see table. Instantaneous trip values shown in table are nominal values.

TD-7100 Rev. 4

ED-Frame Time Current Curve

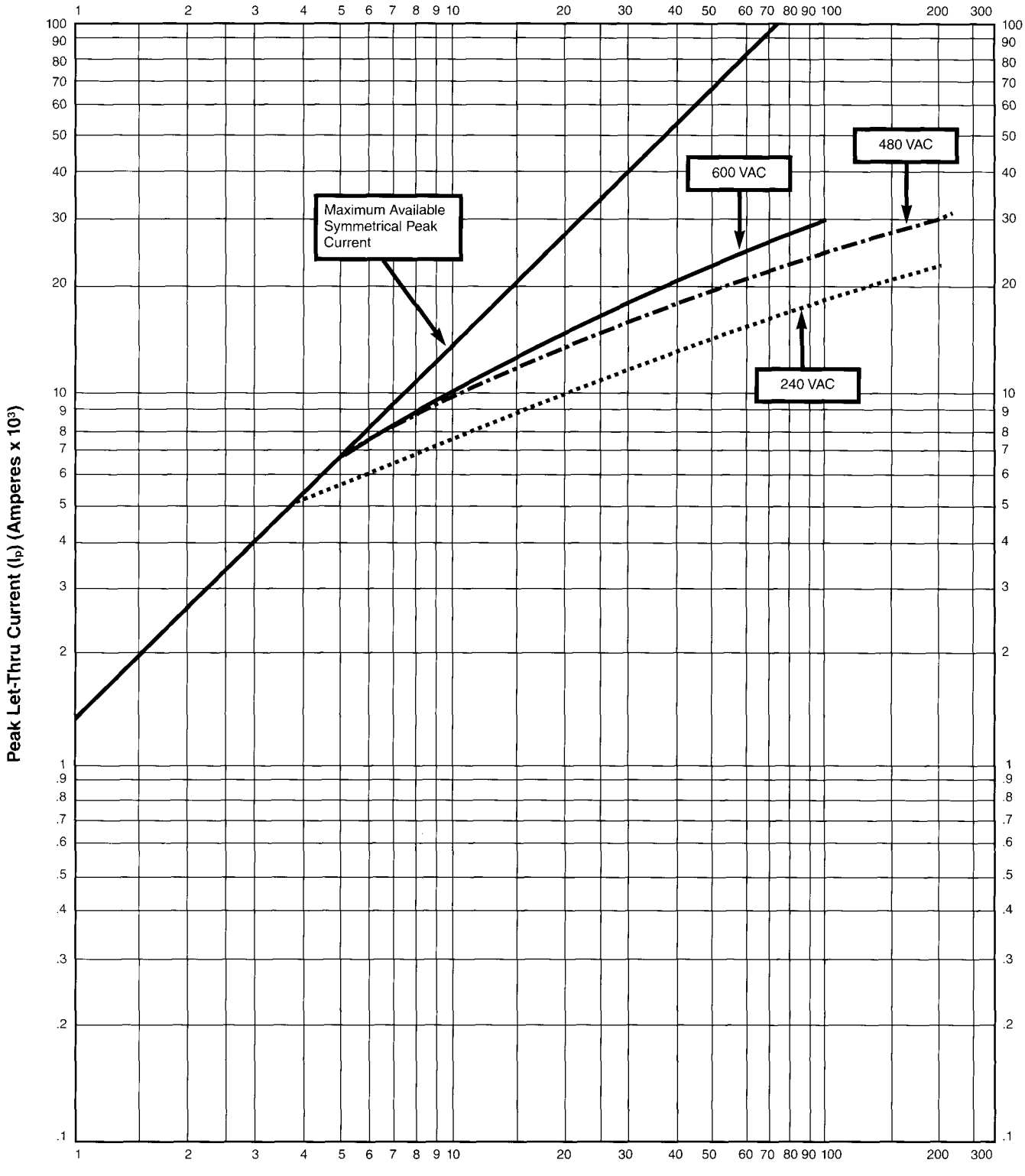
Type CED6



TD-7101

ED-Frame Peak Let-Thru Current (I_p) Curve

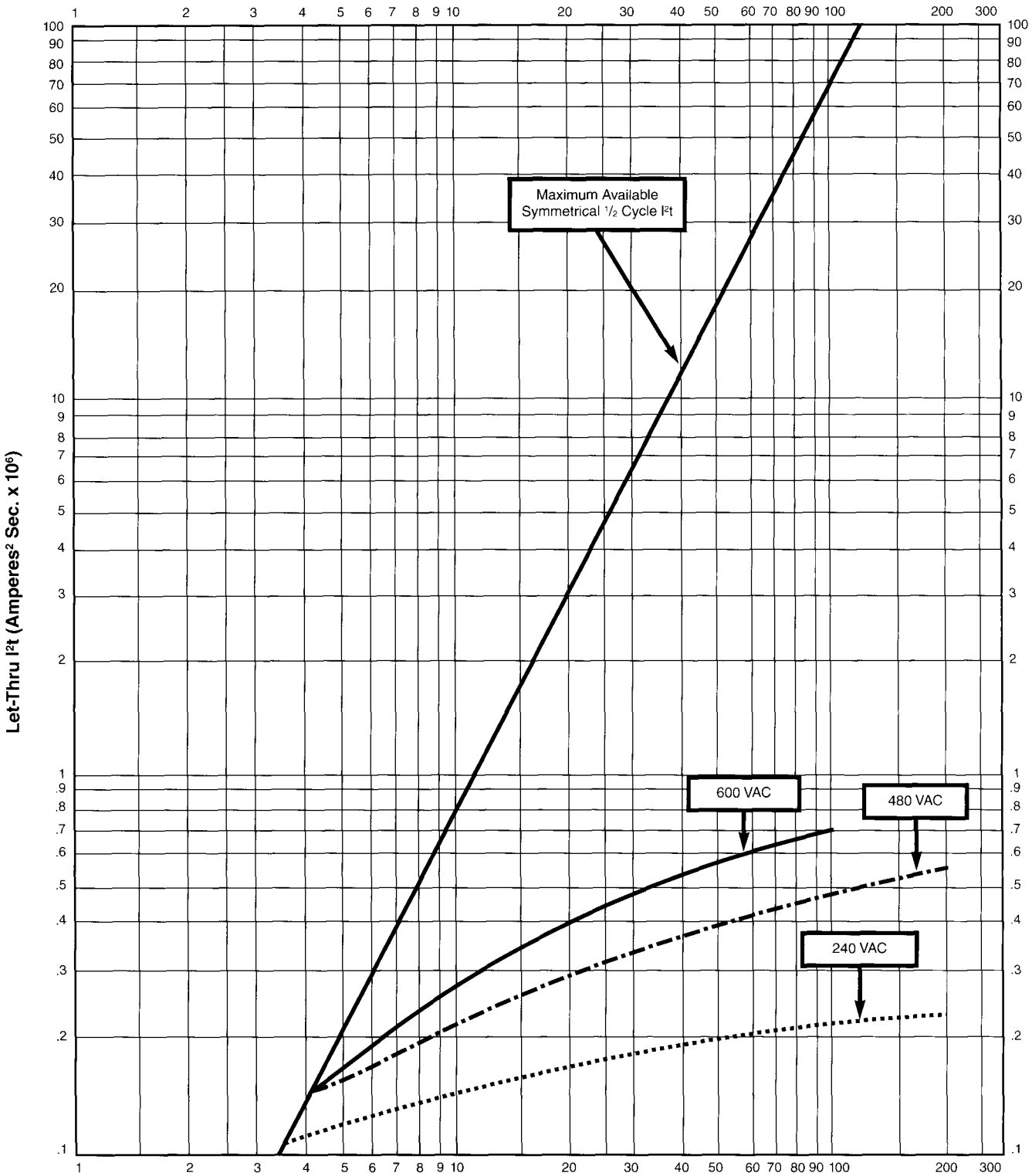
Type CED6


Maximum Available Symmetrical Peak Current
600 VAC
480 VAC
240 VAC
Peak Let-Thru Current (I_p) (Amperes x 10^3)
Available Short Circuit Current (RMS Symmetrical Amperes x 10^3)

TD-7101-A (REV. 2)

ED-Frame Let-Thru I^2t Curve

Type CED6



TD-7101-B (REV. 2)

Ordering Information

Circuit Breaker Catalog Numbers

ED2 Non-Interchangeable Trip

1-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA) (RMS Symmetrical Amperes) 120V AC	125V DC
15①	ED21B015	10	5
20①	ED21B020	10	5
25	ED21B025	10	5
30	ED21B030	10	5
35	ED21B035	10	5
40	ED21B040	10	5
45	ED21B045	10	5
50	ED21B050	10	5
60	ED21B060	10	5
70	ED21B070	10	5
80	ED21B080	10	5
90	ED21B090	10	5
100	ED21B100	10	5
SHIPPING: 30 per carton. (Wt. 38 lb.)			

2-Pole

		240V AC	125/250V DC
15	ED22B015	10	5
20	ED22B020	10	5
25	ED22B025	10	5
30	ED22B030	10	5
35	ED22B035	10	5
40	ED22B040	10	5
45	ED22B045	10	5
50	ED22B050	10	5
60	ED22B060	10	5
70	ED22B070	10	5
80	ED22B080	10	5
90	ED22B090	10	5
100	ED22B100	10	5
Molded Case Switch②③ 100	ED22S100A	10	5
SHIPPING: 10 per carton. (Wt. 25 lb.)			

3-Pole

		240V AC	125/250V DC
15	ED23B015	10	N/A
20	ED23B020	10	N/A
25	ED23B025	10	N/A
30	ED23B030	10	N/A
35	ED23B035	10	N/A
40	ED23B040	10	N/A
45	ED23B045	10	N/A
50	ED23B050	10	N/A
60	ED23B060	10	N/A
70	ED23B070	10	N/A
80	ED23B080	10	N/A
90	ED23B090	10	N/A
100	ED23B100	10	N/A
Molded Case Switch②③ 100	ED23S100A	10	N/A
SHIPPING: 10 per carton. (Wt. 38 lb.)			

①Approved for frequent switching applications (SWD duty).
②Includes self-protecting instantaneous element—will trip at currents over 1000A.
③May be used on a circuit capable of delivering not more than the indicated fault current when protected by a fuse or circuit breaker at 100 or 125 amperes.

ED4 Non-Interchangeable Trip

1-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA)③ (RMS Symmetrical Amperes) 120V AC	277V AC	125V DC
15①	ED41B015	25	22	5
20①	ED41B020	25	22	5
25	ED41B025	25	22	5
30	ED41B030	25	22	5
35	ED41B035	25	22	5
40	ED41B040	25	22	5
45	ED41B045	25	22	5
50	ED41B050	25	22	5
60	ED41B060	25	22	5
70	ED41B070	25	22	5
80	ED41B080	25	22	5
90	ED41B090	25	22	5
100	ED41B100	25	22	5
SHIPPING: 30 per carton. (Wt. 38 lb.)				

2-Pole

		240V AC	480V AC	250V DC
15	ED42B015	65	18	30
20	ED42B020	65	18	30
25	ED42B025	65	18	30
30	ED42B030	65	18	30
35	ED42B035	65	18	30
40	ED42B040	65	18	30
45	ED42B045	65	18	30
50	ED42B050	65	18	30
60	ED42B060	65	18	30
70	ED42B070	65	18	30
80	ED42B080	65	18	30
90	ED42B090	65	18	30
100	ED42B100	65	18	30
110	ED42B110	65	18	30
125	ED42B125	65	18	30
Molded Case Switch②③				
100	ED42S100A	65	18	30
125	ED42S125A	65	18	30
SHIPPING: 10 per carton. (Wt. 25 lb.)				

3-Pole

		240V AC	480V AC	250V DC
15	ED43B015	65	18	N/A
20	ED43B020	65	18	N/A
25	ED43B025	65	18	N/A
30	ED43B030	65	18	N/A
35	ED43B035	65	18	N/A
40	ED43B040	65	18	N/A
45	ED43B045	65	18	N/A
50	ED43B050	65	18	N/A
60	ED43B060	65	18	N/A
70	ED43B070	65	18	N/A
80	ED43B080	65	18	N/A
90	ED43B090	65	18	N/A
100	ED43B100	65	18	N/A
110	ED43B110	65	18	N/A
125	ED43B125	65	18	N/A
Molded Case Switch②③				
100	ED43S100A	65	18	N/A
125	ED43S125A	65	18	N/A
SHIPPING: 10 per carton. (Wt. 38 lb.)				

③IEC interrupting ratings are listed on page 51.

Ordering Information

Circuit Breaker Catalog Numbers

ED6 Non-Interchangeable Trip

2-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA)① (RMS Symmetrical Amperes) Volts AC 240	480	600	Volts DC 250	500
15	ED62B015	65	25	18	30	N/A
20	ED62B020	65	25	18	30	N/A
25	ED62B025	65	25	18	30	N/A
30	ED62B030	65	25	18	30	N/A
35	ED62B035	65	25	18	30	N/A
40	ED62B040	65	25	18	30	N/A
45	ED62B045	65	25	18	30	N/A
50	ED62B050	65	25	18	30	N/A
60	ED62B060	65	25	18	30	N/A
70	ED62B070	65	25	18	30	N/A
80	ED62B080	65	25	18	30	N/A
90	ED62B090	65	25	18	30	N/A
100	ED62B100	65	25	18	30	N/A
110	ED62B110	65	25	18	30	N/A
125	ED62B125	65	25	18	30	N/A
Molded Case Switch②③						
100	ED62S100A	65	25	18	30	N/A
125	ED62S125A	65	25	18	30	N/A

SHIPPING: 10 per carton. (Wt. 25 lb.)

3-Pole

15	ED63B015	65	25	18	N/A	18
20	ED63B020	65	25	18	N/A	18
25	ED63B025	65	25	18	N/A	18
30	ED63B030	65	25	18	N/A	18
35	ED63B035	65	25	18	N/A	18
40	ED63B040	65	25	18	N/A	18
45	ED63B045	65	25	18	N/A	18
50	ED63B050	65	25	18	N/A	18
60	ED63B060	65	25	18	N/A	18
70	ED63B070	65	25	18	N/A	18
80	ED63B080	65	25	18	N/A	18
90	ED63B090	65	25	18	N/A	18
100	ED63B100	65	25	18	N/A	18
110	ED63B110	65	25	18	N/A	18
125	ED63B125	65	25	18	N/A	18
Molded Case Switch②③						
100	ED63S100A	65	25	18	N/A	N/A
125	ED63S125A	65	25	18	N/A	N/A

SHIPPING: 10 per carton. (Wt. 38 lb.)

①IEC interrupting ratings are listed below.
②Includes self-protecting instantaneous element—will trip at currents over 1000A.
③May be used on a circuit capable of delivering not more than the indicated fault current when protected by a fuse or circuit breaker at 100 or 125 amperes.

IEC 157-1 (P1) Interrupting Ratings (kA)

Volts AC (50/60 Hz)	Circuit Breaker Type (3-P Only) ED4	HED4	HED6	CED6
220/240	65	100	100	200
380/415	25	42	30	200

HED4 Non-Interchangeable Trip

1-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA)① (RMS Symmetrical Amperes) 120V AC	277V AC	125V DC
15	HED41B015	100	100	10
20	HED41B020	100	100	10
25	HED41B025	100	100	10
30	HED41B030	100	100	10
35	HED41B035	100	100	10
40	HED41B040	100	100	10
45	HED41B045	100	100	10
50	HED41B050	100	100	10
60	HED41B060	100	100	10
70	HED41B070	100	100	10
80	HED41B080	100	100	10
90	HED41B090	100	100	10
100	HED41B100	100	100	10

SHIPPING: 30 per carton. (Wt. 38 lb.)

2-Pole

		240V AC	480V AC	250V DC
15	HED42B015	100	42	30
20	HED42B020	100	42	30
25	HED42B025	100	42	30
30	HED42B030	100	42	30
35	HED42B035	100	42	30
40	HED42B040	100	42	30
45	HED42B045	100	42	30
50	HED42B050	100	42	30
60	HED42B060	100	42	30
70	HED42B070	100	42	30
80	HED42B080	100	42	30
90	HED42B090	100	42	30
100	HED42B100	100	42	30
110	HED42B110	100	42	30
125	HED42B125	100	42	30

SHIPPING: 10 per carton. (Wt. 25 lb.)

3-Pole

		240V AC	480V AC	250V DC
15	HED43B015	100	42	N/A
20	HED43B020	100	42	N/A
25	HED43B025	100	42	N/A
30	HED43B030	100	42	N/A
35	HED43B035	100	42	N/A
40	HED43B040	100	42	N/A
45	HED43B045	100	42	N/A
50	HED43B050	100	42	N/A
60	HED43B060	100	42	N/A
70	HED43B070	100	42	N/A
80	HED43B080	100	42	N/A
90	HED43B090	100	42	N/A
100	HED43B100	100	42	N/A
110	HED43B110	100	42	N/A
125	HED43B125	100	42	N/A

SHIPPING: 10 per carton. (Wt. 38 lb.)

Ordering Information

Circuit Breaker Catalog Numbers

HED6 Non-Interchangeable Trip

2-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA)① (RMS Symmetrical Amperes) Volts AC 240	480	600	Volts DC 250	500
15	HED62B015	100	30	18	30	N/A
20	HED62B020	100	30	18	30	N/A
25	HED62B025	100	30	18	30	N/A
30	HED62B030	100	30	18	30	N/A
35	HED62B035	100	30	18	30	N/A
40	HED62B040	100	30	18	30	N/A
45	HED62B045	100	30	18	30	N/A
50	HED62B050	100	30	18	30	N/A
60	HED62B060	100	30	18	30	N/A
70	HED62B070	100	30	18	30	N/A
80	HED62B080	100	30	18	30	N/A
90	HED62B090	100	30	18	30	N/A
100	HED62B100	100	30	18	30	N/A
110	HED62B110	100	25	18	30	N/A
125	HED62B125	100	25	18	30	N/A
SHIPPING: 10 per carton. (Wt. 25 lb.)						

3-Pole

15	HED63B015	100	30	18	N/A	25
20	HED63B020	100	30	18	N/A	25
25	HED63B025	100	30	18	N/A	25
30	HED63B030	100	30	18	N/A	25
35	HED63B035	100	30	18	N/A	25
40	HED63B040	100	30	18	N/A	25
45	HED63B045	100	30	18	N/A	25
50	HED63B050	100	30	18	N/A	25
60	HED63B060	100	30	18	N/A	25
70	HED63B070	100	30	18	N/A	25
80	HED63B080	100	30	18	N/A	25
90	HED63B090	100	30	18	N/A	25
100	HED63B100	100	30	18	N/A	25
110	HED63B110	100	25	18	N/A	25
125	HED63B125	100	25	18	N/A	25
SHIPPING: 10 per carton. (Wt. 25 lb.)						

①IEC interrupting ratings are listed on page 49.
②Includes self-protecting instantaneous element.
③May be used on a circuit capable of delivering not more than the indicated fault current when protected by a fuse or circuit breaker at 100 or 125 amperes.

Note: All tolerance ranges are within UL 489 standards.

HHED6 Non-Interchangeable Trip

2-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA)① (RMS Symmetrical Amperes) Volts AC 240	480	600
15	HHED62B015	100	65	25
20	HHED62B020	100	65	25
25	HHED62B025	100	65	25
30	HHED62B030	100	65	25
35	HHED62B035	100	65	25
40	HHED62B040	100	65	25
45	HHED62B045	100	65	25
50	HHED62B050	100	65	25
60	HHED62B060	100	65	25
70	HHED62B070	100	65	25
80	HHED62B080	100	65	25
90	HHED62B090	100	65	25
100	HHED62B100	100	65	25
110	HHED62B110	100	65	25
125	HHED62B125	100	65	25
Molded Case Switch②③				
100	HHED62S100A	100	65	25
125	HHED62S125A	100	65	25

3-Pole

15	HHED63B015	100	65	25
20	HHED63B020	100	65	25
25	HHED63B025	100	65	25
30	HHED63B030	100	65	25
35	HHED63B035	100	65	25
40	HHED63B040	100	65	25
45	HHED63B045	100	65	25
50	HHED63B050	100	65	25
60	HHED63B060	100	65	25
70	HHED63B070	100	65	25
80	HHED63B080	100	65	25
90	HHED63B090	100	65	25
100	HHED63B100	100	65	25
110	HHED63B110	100	65	25
125	HHED63B125	100	65	25
Molded Case Switch②③				
100	HHED63S100A	100	65	25
125	HHED63S125A	100	65	25

Ordering Information

Circuit Breaker Catalog Numbers

CED6 Non-Interchangeable Trip

2-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA)① (RMS Symmetrical Amperes) Volts AC 240	480	600	Volts DC 250	500
15	CED62B015	200	200	100	30	N/A
20	CED62B020	200	200	100	30	N/A
30	CED62B030	200	200	100	30	N/A
40	CED62B040	200	200	100	30	N/A
50	CED62B050	200	200	100	30	N/A
60	CED62B060	200	200	100	30	N/A
70	CED62B070	200	200	100	30	N/A
80	CED62B080	200	200	100	30	N/A
90	CED62B090	200	200	100	30	N/A
100	CED62B100	200	200	100	30	N/A
125	CED62B125	200	200	100	30	N/A
Molded Case Switch②③						
100	CED62S100A	200	200	100	30	N/A
125	CED62S125A	200	200	100	30	N/A
SHIPPING: 5 per carton. (Wt. 20 lb.)						

3-Pole

Ampere Rating	Complete Breaker Unenclosed Catalog Number	UL Interrupting Ratings (kA)① (RMS Symmetrical Amperes) Volts AC 240	480	600	Volts DC 250	500
15	CED63B015	200	200	100	N/A	50
20	CED63B020	200	200	100	N/A	50
30	CED63B030	200	200	100	N/A	50
40	CED63B040	200	200	100	N/A	50
50	CED63B050	200	200	100	N/A	50
60	CED63B060	200	200	100	N/A	50
70	CED63B070	200	200	100	N/A	50
80	CED63B080	200	200	100	N/A	50
90	CED63B090	200	200	100	N/A	50
100	CED63B100	200	200	100	N/A	50
125	CED63B125	200	200	100	N/A	50
Molded Case Switch②③						
100	CED63S100A	200	200	100	N/A	N/A
125	CED63S125A	200	200	100	N/A	N/A
SHIPPING: 5 per carton. (Wt. 30 lb.)						

Instantaneous Trip (Motor Circuit Protectors)

Ampere Rating	Complete Breaker Unenclosed Catalog Number ED6-ETI (3-Pole)	CED6-ETI (3-Pole)	Instantaneous Trip Setting (Amperes) All Values are Nominal Low	2	3	4	High
1	ED63A001	CED63A001	2.6	4.5	6	7.5	9
2	ED63A002	CED63A002	7	11	15	19	22
3	ED63A003	CED63A003	10	17	23	30	35
5	ED63A005	CED63A005	16	26	36	46	54
10	ED63A010	CED63A010	30	50	70	85	100
25	ED63A025	CED63A025	55	90	125	155	180
30	ED63A030	CED63A030	80	135	185	235	270
40	ED63A040	CED63A040	115	185	255	325	375
50	ED63A050	CED63A050	180	300	410	520	600
100	ED63A100	CED63A100	315	540	740	890	1000
125	ED63A125	CED63A125	500	720	920	1100	1250
SHIPPING:	1 per carton. (Wt. 3.8 lb.)	1 per carton. (Wt. 6 lb.)					

①IEC interrupting ratings are listed on page 49.
②Includes self-protecting instantaneous element.
③May be used on a circuit capable of delivering not more than the indicated fault current when protected by a fuse or circuit breaker at 100 or 125 amperes.

Note: All tolerance ranges are within UL 489 standards.

Ordering Information—Accessory Combinations

Auxiliary Switch

Control Voltage		1 Auxiliary Switch	1 Alarm Switch and 1 Auxiliary Switch	1 Alarm Switch and 2 Auxiliary Switches	2 Auxiliary Switches
AC	DC	Catalog Number	Catalog Number	Catalog Number	Catalog Number
120		A01ED62	A01ED62B	A02ED62	A02ED62B
208		A01ED62	A01ED62B	A02ED62	A02ED62B
240		A01ED62	A01ED62B	A02ED62	A02ED62B
277		A01ED64	A01ED64B	N/A	N/A
480		A01ED64	A01ED64B	N/A	N/A
600		N/A	N/A	N/A	N/A
	24	A01ED62	A01ED62B	A02ED62	A02ED62B
	48	A01ED62	A01ED62B	A02ED62	A02ED62B
	125	A01ED62	A01ED62B	A02ED62	A02ED62B
	250	A01ED62	A01ED62B	A02ED62	A02ED62B

Shunt Trip

Control Voltage		1 Shunt Trip	1 Shunt Trip and 1 Auxiliary Switch	1 Shunt Trip, 1 Auxiliary Switch and 1 Alarm Switch	1 Shunt Trip and 1 Alarm Switch	1 Shunt Trip and 2 Auxiliary Switches
AC	DC	Catalog Number	Catalog Number	Catalog Number	Catalog Number	Catalog Number
24		S17ED60	N/A	N/A	N/A	N/A
48		S18ED60	N/A	N/A	N/A	N/A
120		S01ED60	S01ED62A	S01ED62AB	S01ED62B	S01ED62AA
208		S02ED60	S02ED62A	S02ED62AB	S02ED62B	S02ED62AA
240		S03ED60	S03ED62A	S03ED62AB	S03ED62B	S03ED62AA
277		S15ED60	S15ED64A	S15ED64AB	S15ED64B	N/A
480		S04ED60	S04ED64A	S04ED64AB	S04ED64B	N/A
600		S06ED60	N/A	N/A	N/A	N/A
	24	S07ED60	S07ED62A	S07ED62AB	S07ED62B	S07ED62AA
	48	S09ED60	S09ED62A	S09ED62AB	S09ED62B	S09ED62AA
	125	S11ED60	S11ED62A	S11ED62AB	S11ED62B	S11ED62AA
	250	S13ED60	S13ED62A	S13ED62AB	S13ED62B	S13ED62AA

Undervoltage Trip

Control Voltage		1 Undervoltage Trip	1 Undervoltage Trip and 1 Auxiliary Switch	1 Undervoltage Trip, 1 Auxiliary Switch and 1 Alarm Switch	1 Undervoltage Trip and 1 Alarm Switch	1 Undervoltage Trip and 2 Auxiliary Switches
AC	DC	Catalog Number	Catalog Number	Catalog Number	Catalog Number	Catalog Number
120		U01ED60	U01ED62A	U01ED62AB	U01ED62B	U01ED62AA
208		U02ED60	U02ED62A	U02ED62AB	U02ED62B	U02ED62AA
240		U03ED60	U03ED62A	U03ED62AB	U03ED62B	U03ED62AA
277		U16ED60	U16ED64A	U16ED64AB	U16ED64B	N/A
480		U06ED60	U06ED64A	U06ED64AB	U06ED64B	N/A
600		U08ED60	N/A	N/A	N/A	N/A
	24	U13ED60	U13ED62A	U13ED62AB	U13ED62B	U13ED62AA
	48	U14ED60	U14ED62A	U14ED62AB	U14ED62B	U14ED62AA
	125	U10ED60	U10ED62A	U10ED62AB	U10ED62B	U10ED62AA
	250	U12ED60	U12ED62A	N/A	N/A	U12ED62AA

Bell Alarm Switch

Control Voltage		1 Alarm Switch
AC	DC	Catalog Number
120		B00ED62
208		B00ED62
240		B00ED62
277		B00ED64
480		B00ED64
600		N/A
	24	B00ED62
	48	B00ED62
	125	B00ED62
	250	B00ED62

Ground Fault Relays (Equipment Protection Only)

5mA	30mA
GF01ED65	GF01ED60
GF01ED65BO	GF01ED60BO
GF01ED65BC	GF01ED60BC

NOTE

Accessory module is used on all ED-Frame circuit breakers. Accessory *can not* be used with obsolete breaker types E2, E4, E6, HE4, HE6, CLE.

Each catalog number represents an add-on module. *Only one module can be added to a circuit breaker.*

Ordering Information

Additional Accessories

Item	Catalog No.
Pressure Wire Connectors	
15-25A Line & Load Side	SA1E025
30-100A Single-Pole Line Side Only Multi-Pole Line & Load Side CED6 Load Side Only	LN1E100
30-60A Single-Pole Load Side Only CED6 Load Side Only	LD1E060
70-100A Single-Pole Load Side Only CED6 Load Side Only	LD1E100
110-125A Line & Load Side	TA1E6125
2- and 3-Pole 30-125A	TC1ED6150
Compression Connector 15-125A Line & Load Side	CCE125
Handle Blocking Device	E2HBL
Padlocking Device	ED2HPL
Rear Connecting Studs	
Line Side (Long)	RS2641
Load Side (Long)	RS2642
Line Side (Short)	RS2643
Load Side (Short)	RS2644
Plug-In Adaptors	
Line Side (2-Pole)	PC2637
Load Side (2-Pole)	PC2638
Line Side (3-Pole)	PC2657
Load Side (3-Pole)	PC2658
Switchboard Mounting Plates	
CED6 Breaker Type	PL2617
All Other Types	PL2616
Ground Fault Sensing Relay Kits (30mA)	
Basic Kit	GF01ED60
Basic Kit with Normally Open Bell Alarm	GF01ED60B0
Basic Kit with Normally Closed Bell Alarm	GF01ED60BC
Ground Fault Sensing Relay Kits (5mA)	
Basic Kit	GF01ED65
Basic Kit with Normally Open Bell Alarm	GF01ED65B0
Basic Kit with Normally Closed Bell Alarm	GF01ED65BC
Rotary Handle Operators	
Standard Depth	D11CEU1
Variable Depth	D11CEU2
Rotary Handle Operators	
Complete Mechanism	
Standard Depth	CRHOESD
Variable Depth	CRHOEVD
Handle	RHOH ①
Breaker Operator	RHOEBO
Shaft	
Standard Depth	RHOSSD
Variable Depth	RHOSVD

① For 4-4x application, order RHOH4 instead of RHOH.

Item	Catalog No.
Rotary Handle Operators	
Standard Depth	E2RH1
Variable Depth	E2RHV9
Flange Mount Handle Operator	
Complete Mechanism	FHOE036
Handle	FHOH ①
Breaker Operator	FHOEBO
Standard Cable (36 in.)	FHOEC036
Optional Cable (48 in.)	FHOEC048
Door Latch Mechanisms	
Left Side	DKL2,DKL3
Right Side	DKR2,DKR3
Electric Motor Operators	
120V AC	MO6E120
240V AC	MO6E240
Connector Straps	
Outside Strap	CS3600R CS3602R
Inside Strap	CS3601R CS3603R
Single Pole Mounting Bracket	E2BMB
Back Mounting Plate	E2BMB
Mounting Screw Kits	MSE6 ② MSE6100 ③
Enclosures	
Breaker Types ED2, ED4, ED6, HED4, HED6, HHED6	
Type 1 (Surface Mounting)	E2N1S
Type 1 (Flush Mounting)	E2N1F
Type 3R	E2N3R
Type 4, 4x	ED6SS4
Type 7, 9 15-60A	EA
70-100A	EB
Type 12	E2N12
Breaker Type CED6	
Type 1 (Surface Mounting)	CLE6NIS
Type 1 (Flush Mounting)	CLE6NIF
Type 3R	CLE6N3R
Type 12	CLE6N12
Time Current Curves	
Types ED2, ED4, ED6, HED4, HED6, HHED6	TD-7100
Type CED6	TD-7101
Let-Thru Curves	
Peak Current (I_p)	TD-7101-A
I^2t	TD-7101-B

① For 4-4x application, order FHOH4 instead of FHOH.
② Consists of 4 screws and assorted washers and/or nuts.
③ Consists of 100 screws and hardware.

UL Listings and File Numbers

Industry Specifications

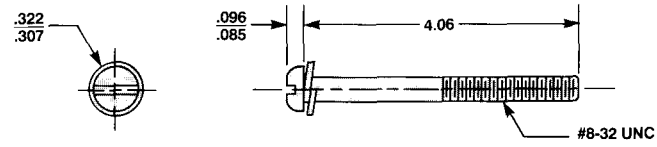
I-T-E Item	UL-489 File Number	CSA Report Number
Breakers	E10848	LR13077
Terminal Connectors	E23615 (SP)	
Plug-In Connectors	E23615	
Rear Studs	E23615	
Add-On External Accessories	E69455	LR13077
Shunt Trip		
Undervoltage Trip		
Aux. Switch		
Bell Alarm Switch		
Molded Case Switch	E68312	LR42022
Enclosures	E10848	
ETI Breakers	E10848	LR42022

National Fire Protection Assoc. (National Electrical Code®).

Federal Specification W-C-375B/GEN.

Underwriters Laboratories, Inc. (UL 489).

Canadian Standards Association (C22.2 No. 5).



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1-800-964-4114 or 800-241-4453
www.sea.siemens.com/sales/salesoffices.html

For Product Information
www.sea.siemens.com/power/

tyco Electronics

Energy Division
http://energy.tycoelectronics.com

Installation and Operating Manual
Switchboard Integra 1540, 1000, 0640, 0440 0340 & 0240 Digital Metering Systems

Crompton INSTRUMENTS

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tyco / Electronics / Energy Division

Crompton
Switchboard Integra
Multifunctional metering for Three-phase Electrical Systems

Models 1540, 1000, 0640, 0440, 0340, 0240

Operating Instructions

Important safety information is contained in the seperate installation leaflet. Installers must familarise themselves with this information before installation

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Crompton INSTRUMENTS

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1 Introduction

This manual provides operating instructions for the Crompton Switchboard Integra series of Digital Metering Systems. Some versions of the Integra incorporate the metering transducer that provides the interface for the measurement of power supply parameters such as voltage, current, power, frequency etc. In other versions, the display and transducer are separate, interconnected units. The display allows the user to set up metering transducer parameters and to monitor the measurements. Some Integra models can be supplied as either an integral or display-only version, while others are only available in one format. This manual provides user instructions.

A separate leaflet provides installation instructions.

Table1 lists the various models of Integra and shows their distinctive characteristics.

Table 1 Summary of Integra models

Model	V	A	F	PF	kW	kWh	THD	Analogue	Serial	Pulse	Freq
0240	V		F								45-65 Hz
0340	V	A									45-65 Hz
0440	V	A	F								360-400 Hz
0640	V	A	F								45-65 Hz
1000	V	A	F	PF	kW	kWh			RS485 option	Pulse option	45-65 Hz
1540	V	A	F	PF	kW	kWh	THD	Analogue option*	RS485 option	Pulse option	45-65 Hz

* When used with an 1560/80 transducer that includes analogue options.

Voltage and current readings are true RMS, up to the 15th harmonic (31st for 1560/80 transducer).

The unit can be powered from an auxiliary a.c. or d.c. supply that is separate from the metered supply. Versions of each model are available to suit 100-250V 45-65 Hz a.c./d.c. and 12-48V d.c nominal supplies.

In this manual, the graphic

0240	0340	0440	0640	1000	1540

is used to show the models to which a screen applies. Boxes are greyed out to show models that do not have that type of screen.

0240	0340	0440	0640	1000	1540

This example indicates that the screen only applies to Models 1000 and 1540.

0240	0340	0440	0640	1000	1540	Option

This indicates that the screen is an option on models 1000 and 1540.

Important safety information is contained in the accompanying installation instructions. Installers must familarise themselves with this information before installation.

1.1 Unit Characteristics

Default display

1.1.1 0240

The 0240 will display the following parameters:

- System voltage (average of all phases)
- System frequency (Hz)
- Voltage line to neutral for each phase (4-wire systems only)
- Voltage line to line for each phase (calculated in 4-wire)

The 0240 has Set-up screens for potential transformer primary and secondary voltages.

Default display

1.1.2 0340

The 0340 will display the following parameters:

- System voltage (average of all phases)
- System current (average of all phases)
- Voltage line to neutral for each phase (4-wire systems only)
- Voltage line to line for each phase (calculated in 4-wire)
- Current in each line.

The 0340 has Set-up screens for:

- Full-scale current value
- Potential transformer primary and secondary voltages.

Default display

1.1.3 0440 and 0640

The 0440 operates on a mains frequency of 400 Hz nominal and the 0640 at 45-65 Hz. The units can measure and display the following parameters:

- System voltage (average of all phases)
- System current (average of all phases)
- System frequency (Hz)
- Voltage line to neutral for each phase (4-wire systems only)
- Voltage line to line for each phase (calculated in 4-wire)
- Current in each line

The 0440 and 0640 have Set-up screens for:

- Full-scale current value
- Potential transformer primary and secondary voltages.

Default display

1.1.4 1000

The 1000 will display the following parameters:

- System voltage (average of all phases)
- System current (average of all phases)
- System frequency (Hz)
- Voltage line to neutral for each phase (4-wire systems only)
- Voltage line to line for each phase (calculated in 4-wire)
- Current in each line
- Neutral current[1]
- Power Factor
- Active Power (kW)
- Reactive Power (kVAr)
- Apparent Power (kVA)
- Active Energy (kWh)[2]
- Reactive Energy (kVArh)[2]
- Total System Current Demand (AD)[2]
- Total System Active Power Demand (kWD)[2]
- Maximum Total System Current Demand (AD)[2]
- Maximum Total System Active Power Demand (kWD)[2]

The 1000 has Set-up screens for:

- Full-scale current value
- Potential transformer - primary voltages.
- Demand integration time and energy/demand resets
- Pulse output duration and rate divisor (option)
- RS485 serial Modbus parameters (option)

A pulsed relay output, indicating kWh, and an RS485 Modbus™ output are available as optional extras. The Modbus output option allows remote monitoring from a Modbus master.

[1]Neutral referenced parameters are only available when used with 4-wire and single phase configured transducers.
[2]All energy and demand measurements are importing only unless connected as exporting unit.

Default display

1.1.5 1540

The1540 is available either as a display unit operating in conjunction with a 15xx measurement transducer or as a self-contained unit incorporating a transducer. The unit can measure and display the following:

- System voltage (average of all phases)
- System current (average of all phases)
- System frequency (Hz)
- Voltage line to neutral for each phase (4-wire systems only)
- Voltage line to line for each phase (calculated in 4-wire)
- Current in each line.
- Neutral current[1]
- Power Factor
- Active Power (kW)[2]
- Reactive Power (kVAr)[2]
- Apparent Power (kVA)
- Active Energy (kWh)[2]
- Reactive Energy (kVArh)[2]
- Total System Current Demand (Admd)[2]
- Total System Active Power Demand (kWD)[2]
- Maximum Total System Current Demand (AD)[2]
- Maximum Total System Active Power Demand (kWD)[2]

The 1540 has Set-up screens for:

- Full-scale current value
- Potential transformer - primary and secondary voltages (Dis 1540 and Integra 15xx)
- Potential transformer - primary voltages (self contained)
- Demand integration time and energy/demand resets
- Pulse output duration and rate divisor (option)
- RS485 serial Modbus parameters (option)
- Analogue current output (option, with separate transducer only)

A pulsed relay output, indicating kWhr (and Kvarh on the two part Dis 1540 and Integra 15xx combination), and an RS485 Modbus™ output are available as optional extras. The Modbus output option allows remote monitoring from another display (not self contained) or a Modbus master.

The Analogue current output option provides a current output that indicates the value of a chosen parameter.

[1] Neutral referenced parameters are only available when used with 4-wire and single phase configured transducers.

[2] All energy and demand measurements are importing only unless connected as exporting unit.

1.2 Maximum Power

Products covered in this manual are limited to a maximum power of 360 MW. During set-up, primary voltage and current setting are checked and the unit will not accept entries that breach the 360 MW limit. This is covered in more detail in the sections that show primary voltage and current set-up. The Maximum Power restriction of 360 MW refer to 120% of nominal current and 120% of nominal voltage, i.e. 250 MW nominal system power.

1.3 Secondary Voltage

0240	0340	0440	0640	1000	1540

Most of the products described in this manual allow the user to specify, within a range, the secondary voltage of the potential transformer (PT) with which it is to be used. The exception is the Integra 1000 and self contained Integra 1540, which has the PT secondary factory set. On the Integra 1000/1540, the user cannot change this value.

1.4 Demand Calculation

0240	0340	0440	0640	1000	1540

The maximum power consumption of an installation is an important measurement, as most power utilities base their charges on it. Many utilities use a thermal maximum demand indicator (MDI) to measure this peak power consumption. An MDI averages the power consumed over a number of minutes, reflecting the thermal load that the demand places on the supply system.

The Integra uses a sliding window algorithm to simulate the characteristics of a thermal MDI instrument, with the demand being calculated once per minute.

The demand period can be reset, which allows synchronisation to other equipment. When it is reset, the values in the Demand and Maximum Demand registers are set to zero.

Demand Integration Times can be set to 8, 15, 20 or 30 minutes.

The number of sub-intervals, i.e. the demand time in minutes, can be altered either by using the Demand Integration Time set-up screen (see Section 3.8) or via the RS485 port, where available, using the Modbus™ protocol.

During the initial period, when the elapsed time since the demands were last reset or since the Integra was switched on is less than one minute, the maximum demands (current MaxAD and power MaxkWD) will remain at zero and not follow the instantaneous demands.

Maximum Demand is the maximum power or current demand that has occurred since the unit was last reset as detailed in Section 3.9 Resets.

1.5 RS485 Serial Option

0240	0340	0440	0640	1000	1540	Option

This option is available on two-part (separate transducer and display) units and on 1000 and self-contained 1540 units.

This option uses an RS485 serial port with Modbus or JC NII protocol to provide a means of remotely monitoring and controlling the Integra unit. Both protocols are supplied in the same unit. Communications automatically configure according to the protocol that is recognized when the master sends a message.

Where the installation comprises separate display and transducer units, the display communicates with the transducer using a modified Modbus protocol via the RS485 port. Such a transducer may have two such ports, either or both of which can be used for connection to a display. Where a port is available, it can be connected to a PC for control and monitoring purposes.

Set-up screens are provided for setting up the Modbus port. See Sections 3.12 to 3.14. These screens are not applicable for setting up a port connected to a display unit, as the characteristics of such a port are preset. On a two-port unit, communications settings made from an Integra display affect the other communications port, unless the second port is also connected to a display, in which case the changes have no effect.

1.6 Pulse Output Option

0240	0340	0440	0640	1000	1540	Option

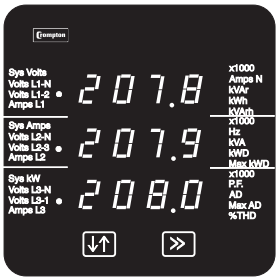
This option provides a relay pulse output indication of measured active energy (kWh). The unit can produce one pulse for every 1, 10 or 100kW of energy consumed. Two-part 1540 display units operating with 1560 or 1580 transducers can also produce a pulse for every 1000 kW of energy consumed. The pulse divisor can be set from the Set-up screen as detailed in Section 3.11 Pulse Rate. The pulse width (duration) can be set as detailed in Section 3.10 Pulsed Output, Pulse Duration. On two part units, two pulsed outputs are available with common pulse rate divisions and pulse widths.

1.7 Analogue Output Option

0240	0340	0440	0640	1000	1540	Option

This option is available on two-part (separate transducer and display) units and provides an analogue current output that indicates the value of a chosen parameter. The parameter can be chosen and set up via the set-up screen as described in Section 3.15 Analogue Output Set Up.

2 Display Screens



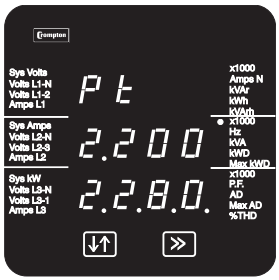
Voltage display

2.1 Layout

The screen is used in two main modes: display of measured values and parameter setup.

In display mode, three measured values can be shown, one on each row. For each row, the LED indicators show the parameter being measured and the units.

The >> button moves between display screens.

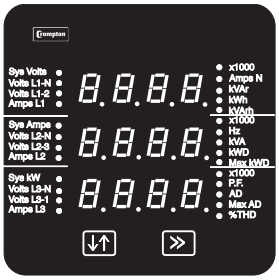


Setup confirmation screen

In Set up mode, the top row shows an abbreviation of the parameter name, the middle row shows the parameter value being set and the bottom row is used for confirmation of the entered value. In general, the ↓↑ key changes a parameter value and the >> key confirms a value and moves on to the next screen.

This example is the potential transformer primary voltage confirmation screen.

The example screens shown in this manual are those relating to the 1540 models – the most complex. The screens for simpler models are similar except that some of the parameters and values are omitted. Section 1.1 shows the default display screens for the various models.



2.2 Start Up Screens

Initially, when power is applied to the Integra Display, two screens will appear. The first screen lights the LED's and can be used as a display LED check.

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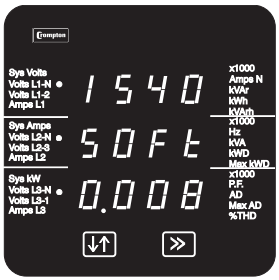


The second screen indicates the firmware installed in the display unit. This example states that the version is 0.008. The version on a particular unit will differ in line with ongoing development and improvements.

After a short delay, the default Display screen will appear.

Use the >> (Next) key to move from one screen to the next in the sequence. The sequence depends on the supply configuration (single phase 2 or 3 wire, 3 phase 3 or 4 wire).

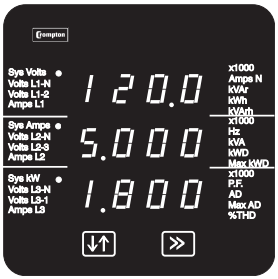
2.3 System Screen

0240	0340	0440	0640	1000	1540

The following sections show 3 and 4 wire systems.

Single phase 2 and 3 wire systems have similar display screens.

The system screen is the default display. It appears when the unit is energised after the start up screens. Section 1.1 shows the default system screens for the various models.



System Average Voltage (Volts)*

System Average Line Current (Amps).

System Total Active Power (kW).

Pressing key >> moves to the next screen

* Line to Line for 3 wire systems, Line to Neutral for 4 wire and single phase 3 wire systems.

2.4 System %THD Screen

0240	0340	0440	0640	1000	1540

Average % Total Harmonic Distortion for System Voltages.

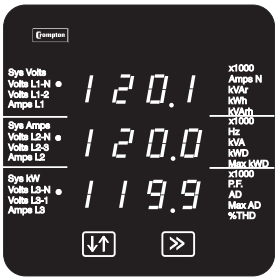
Average % Total Harmonic Distortion for System Currents.

Key >> moves to next screen.

2.5 Line to Neutral Voltages

0240	0340	0440	0640	1000	1540

Three phase, four wire systems only.



Voltage Line 1 to Neutral (Volts).

Voltage Line 2 to Neutral (Volts).

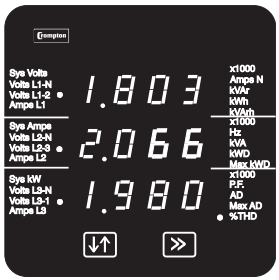
Voltage Line 3 to Neutral (Volts).

Key >> moves to next screen.

2.6 Line to Neutral Voltage %THD

0240	0340	0440	0640	1000	1540

Three-phase, four wire systems only.



%THD of Line 1 Voltage to Neutral.

%THD of Line 2 Voltage to Neutral.

%THD of Line 3 Voltage to Neutral.

Key >> moves to next screen.

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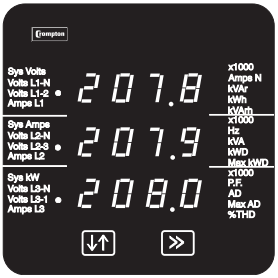
2.7 Line to Line Voltages

0240	0340	0440	0640	1000	1540



Voltage Line 1 to Line 2 (Volts).

Voltage Line 2 to Line 3 (Volts).

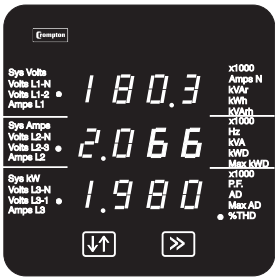
Voltage Line 3 to Line 1 (Volts).

Key >> moves to next screen.

2.8 Line to Line Voltages %THD

0240	0340	0440	0640	1000	1540

Three-phase, three wire systems only.



Line 1 to Line 2 Voltage %THD.

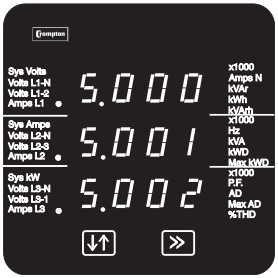
Line 2 to Line 3 Voltage %THD.

Line 3 to Line 1 Voltage %THD.

Key >> moves to next screen.

2.9 Line Currents

0240	0340	0440	0640	1000	1540



Line 1 Current (Amps).

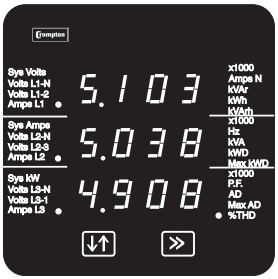
Line 2 Current (Amps).

Line 3 Current (Amps).

Key >> moves to next screen.

2.10 Line Currents %THD

0240	0340	0440	0640	1000	1540



Line 1 Current %THD.

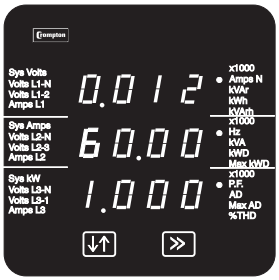
Line 2 Current %THD.

Line 3 Current %THD.

Key >> moves to next screen.

2.11 Neutral Current, Frequency and Power Factor

0240	0340	0440	0640	1000	1540



Neutral Current (Amps).
(4-wire and single phase 3 wire system only).

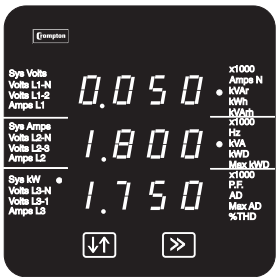
Frequency (Hz).

Power Factor (0 to 1, on 1000 and combined 1540; sign (-) prefix, on 1540 two part: prefix C indicates Capacitive load and L = Inductive).

Key >> moves to next screen.

2.12 Power

0240	0340	0440	0640	1000	1540



Reactive Power (kVAr).

Apparent Power (kVA).

Active Power (kW).

Key >> moves to next screen.

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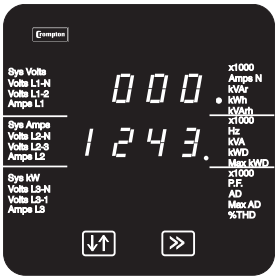
2.13 Active Energy (kWh)

0240	0340	0440	0640	1000	1540

This is the energy that has been consumed since the unit was last reset (see Section 3.9 Resets).



Active Energy (kWh)

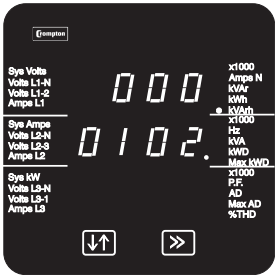
7 digit reading i.e. 0001243.

Key >> moves to next screen.

2.14 Reactive Energy (kVArh)

0240	0340	0440	0640	1000	1540

This is the reactive energy that has been consumed since the unit was last reset (see Section 3.9 Resets). The reading shows the energy (kVArh) in the reactive component of the supply.



Reactive Energy (kVArh)

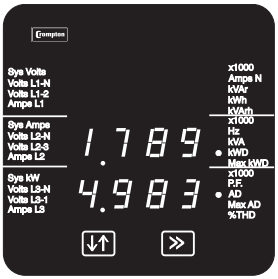
7 digit reading i.e. 0000102

Key >> moves to next screen.

2.15 Demand

0240	0340	0440	0640	1000	1540

This screen displays the present demand, i.e. the maximum power and the maximum current demanded during the defined integration window period. See Section 3.8 Demand Integration Time.



System Total Active Power Demand (kWD)

System Total Current Demand (AD)

Key >> moves to the next screen.

2.16 Maximum Demand

0240	0340	0440	0640	1000	1540

This screen displays the maximum power and the maximum current that has been demanded since the unit was last reset (see Section 3.9 Resets).

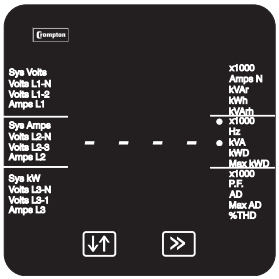
Maximum System Total Active Power Demand (kWD)

Maximum System Total current Demand (AD)

Key >> returns to the start of the sequence with the System Screen

2.17 Over Range

The displayed values must be in the range –999 x 1000 to 9999 x 1000. Any parameter value outside this range will cause the display to show overrange.



This situation will be indicated by displaying four bars in the appropriate line:

The value on the middle line is over range.

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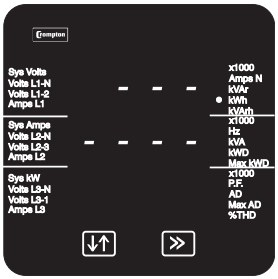
2.18 kWh and kVArh Display Range

0240	0340	0440	0640	1000	1540

The kWh and kVArh display range is limited to 9999999. If the unit is allowed to increment beyond this value the count will either wrap back to zero (if the 1560/1580 transducer is set to 7 digit mode) or continue to be updated in the 1560/1580 transducer but the display will change to seven bars. The value will continue to be available via the Modbus output.



2.19 Error Messages

The display repeatedly requests new values from the measurement processor. If there is a problem obtaining these values, the display will continue to retry but will alert the user by displaying the message Err1. This message may be seen briefly during conditions of extreme electromagnetic interference with the normal display returning once the interference has ceased.

If the Err1 message persists, try interrupting, for ten seconds, the auxiliary supply (or supplies) to the Integra (display and transducer). This may restore normal operation. Also check that auxiliary power is reaching the transducer and is within specification. Check that there are no problems with the communications cable between the display and transducer, where applicable.

3 Setting up

3.1 Introduction

The following sections give step by step procedures for configuring the Integra transducer for a particular installation using an attached display.

To access the Set-up screens, press and hold the ↓↑ (Adjust) key and the >> (Next) keys simultaneously for five seconds. This brings up the password entry stage. (See Section 3.3 Access).

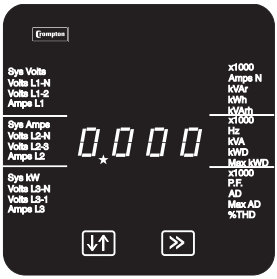
On completion of the last Set-up screen, the program exits Set-up mode and returns to the last selected Display screen. To return to the Display screens at any time during the set up procedures, press the ↓↑ and the >> keys simultaneously for five seconds.

3.2 Number Entry Procedure

When setting up the unit, many screens require the setting up of a number, usually on the middle row of digits. In particular, on entry to the setting up section, a password must be entered. The procedure is as follows:

In general, press the ↓↑ (adjust) key to change something on the current screen. Pressing the >> (next) key normally leaves the current screen unchanged and brings up the next screen.

The example below shows how the number 0000 can be changed to 1234.

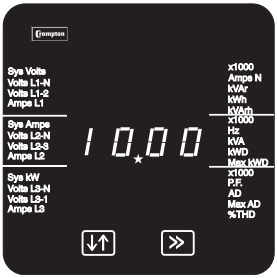


First digit

The digits are set one at a time, from left to right. The decimal point to the right of the digit (* in the picture) flashes to indicate which digit can currently be changed. It thus acts as a cursor. Where the cursor coincides with a genuine decimal point on the display, the decimal point will flash.

Press the ↓↑ key to scroll the value of the first digit from 0 through to 9, the value will wrap from 9 round to 0. For this example, set it to '1'.

Press the >> key to confirm your setting and advance to the next digit.



Second digit

Use the ↓↑ key to set the second digit to the required value.

Press the >> key to confirm your selection and advance to the next digit.

Third digit

Use the ↓↑ key to set the third digit to the required value.

Press the >> key to confirm your selection and advance to the next digit.

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Fourth digit

Use the ↓↑ key to set the fourth digit to the required value.

Press the >> key to confirm your selection. If the unit accepts your entry, the Confirmation screen will appear.

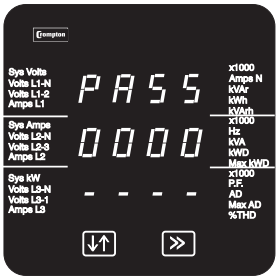
If the unit does not accept your entry, e.g. an incorrect password, a rejection screen will appear, with dashes on the bottom line.

Confirmation

The Confirmation screen shows the entered number on the bottom row with all decimal points showing.

If the displayed number is correct, press the >> key to move to the next Set-up screen.

If not, press the ↓↑ key to return to restart the number entry. The first digit entry screen will appear.



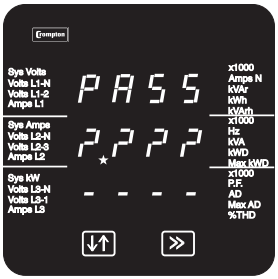
Rejection

If a rejection screen appears, press the ↓↑ key to restart the entry procedure.

3.3 Access

To access the Set-up screens, press the ↓↑ and >> keys simultaneously for five seconds, until the Password Introduction screen appears.

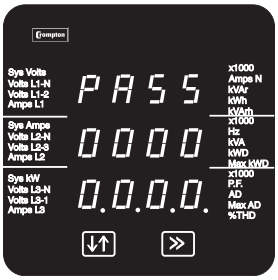
Password protection can be enabled to prevent unauthorised access to Set-up screens. Password protection is not normally enabled when a product is shipped. The unit is protected if the password is set to any four digit number other than 0000. Setting a password of 0000 disables the password protection.



Password introduction

3.3.1 Access with No Password Protection

Press >> from the Password Introduction screen. The 0000 password confirmation screen will appear.



0000 Password confirmation

Press >> again to proceed to the first Set-up screen.

Password introduction

3.3.2 Access with Password Protection

If the unit is protected by a password, proceed as follows:

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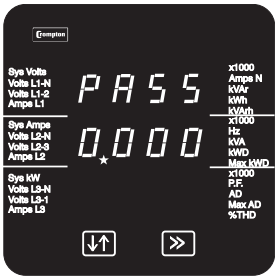


First digit

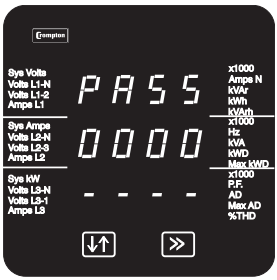
Enter the four-digit password using the method described in Section 3.2 Number Entry Procedure.

Password Confirmation

On pressing >> to confirm the last digit, the Confirmation screen will appear, provided the password is correct.

From the Password Confirmation screen, there is the option of changing the password, as described in Section 3.4 Changing the Password.

To proceed to the first Set-up screen, press >>.



Password Incorrect

If the password is incorrect, the Password Request screen will reappear to permit a retry. Press ↓↑ to start a retry or >> to exit to the Display screens.

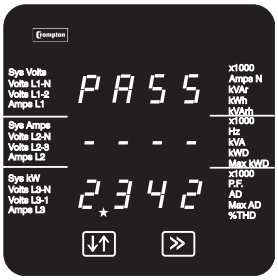
3.4 Changing the Password

The option to change the password is only available from the Password Confirmation screen immediately after the user has entered the existing password, if applicable.

Password Confirmation

Press ↓↑ to start changing the password.

The password screen for the first digit will appear, with the old password on the bottom line.



First new password digit

Set up the new password on the bottom line, as described in Section 3.2 Number Entry Procedure.

On pressing >> to confirm the last digit, the Password Confirmation screen will appear.

New password confirmation

Press >> to confirm the new password. The first Set-up screen will appear.

Press ↓↑ to try again. The first digit screen will appear again.

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3.5 Full Scale Current

0240	0340	0440	0640	1000	1540

This parameter is the value of nominal Full Scale Currents that will be displayed as the Line Currents. This screen enables the user to display the Line Currents inclusive of any transformer ratios. The values displayed represent the current in amps. For example setting 800 on this screen will cause the display to indicate 800 amps when the nominal maximum (typically 5A or factory build option of 1A) current flows through the transducer current inputs.The maximum value is as specification.

Edit

Press >> to accept the present value and move on to the next Set-up screen (Section 3.6 Potential Transformer Primary Voltage).

To change the Full Scale Current, press ↓↑ and change the current value as detailed in Section 3.2 Number Entry Procedure. If the presently displayed current, together with the full scale voltage value, results in an absolute maximum power (120% of nominal current and voltage) of greater than 360 Megawatts, the range of the most significant digit will be restricted.

The Maximum Power restriction of 360 Megawatts refers to 120% of nominal current and 120% of nominal voltage, i.e. 250 Megawatts nominal system power.

When the least significant digit has been set, pressing the >> key will advance to the Full Scale Current Confirmation stage.

The minimum value allowed is 1. The value will be forced to 1 if the display contains zero when the >> key is pressed.

3.6 Potential Transformer Primary Voltage

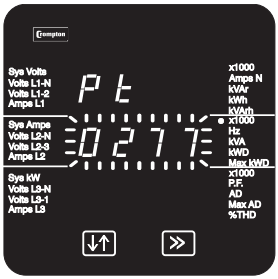
0240	0340	0440	0640	1000	1540

This value is the nominal full scale voltage which will be displayed as L1-N, L2-N and L3-N for a four wire system, L1-2, L2-3 and L3-1 in a three wire system or system volts for single phase. This screen enables the user to display the line to neutral and line to line voltages inclusive of any transformer ratios. The values displayed represent the voltage in kilovolts (note the x1000 indicator). For example, on a 2.2kV system with 110V potential transformer secondary, set 2.200 at this screen.

If there is no potential transformer (PT) in the system, i.e. the voltage terminals are connected directly to the metered voltage, leave this value unchanged and skip this set up step.

If the PT primary and secondary values are changed and it is desired to revert to a set-up with no PT, then set both PT primary and secondary values to the nominal maximum voltage for the Integra transducer.

To set up the PT primary, proceed as follows:



Decimal Point

To accept the currently displayed value, press >>. The screen will move on to the next Set-up screen (Section 3.7 Potential Transformer Secondary Value).

Press ↓↑ to change the PT Primary voltage.

Initially all the digits of the present value will be flashing and the decimal point position will be illuminated. This is to indicate that initially the 'multiplier' must be selected. Press ↓↑ to set the decimal point position.

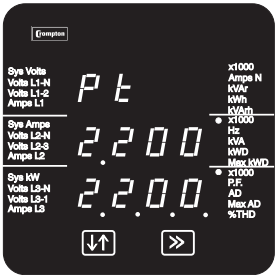
Note that the x1000 indicator is on.

Press >> to accept the displayed (decimal point position). The digits stop flashing and the PT Primary Value screen appears

Digit Edit

Set the display to read the value of the PT Primary voltage, using the method described in Section 3.2 Number Entry Procedure. The primary voltage that can be set will be restricted to a value such that, together with the full scale current value (previously set), the absolute maximum power (120% of nominal current and voltage) cannot exceed 360 Megawatts.

After the last digit has been accepted, the Confirmation screen will appear.



Confirmation

This example confirmation screen shows a primary voltage setting of 2.2 kV.

Press >> to accept the displayed PT Primary Voltage. The next Set-up screen will appear (Section 3.7 Potential Transformer Secondary Value).

To change the displayed value, press ↓↑. The Decimal Point screen will reappear.

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3.7 Potential Transformer Secondary Value

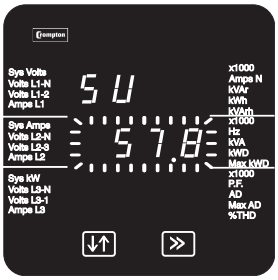
0240	0340	0440	0640	1000	1540

In Model 1000 and 1540 combined, the PT Secondary Value is factory set, as marked on the barrel. The PT Secondary Value is user programmable on the 1540 and Integra 1560 two part.

This value must be set to the nominal full scale secondary voltage which will be obtained from the transformer when the potential transformer (PT) primary is supplied with the voltage defined in Section 3.6 Potential Transformer Primary Voltage. This defines the actual full scale voltage that will be obtained from the PT secondary and measured by the unit. The ratio of the full scale primary to full scale secondary voltage is the transformer ratio. Given full scale primary and secondary voltages, the unit knows what primary voltage to display for any given measured secondary voltage.

The secondary voltage displayed is in volts. Following the previous example, on a 2.2 kV system with 110V PT secondary, set this screen to 110.0.

If there is no PT associated with this unit, leave this value unchanged and skip this step.



Decimal Point

To accept the displayed PT Secondary Voltage, press >>. The next Set-up screen will appear (Section 3.8 Demand Integration Time).

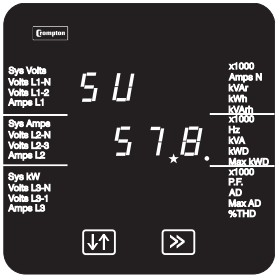
To change the PT Secondary Voltage display, press ↓↑.

Note that the decimal point edit screen will only appear when the display unit is connected to a transducer designed for connection to voltages in the range 57.7 to 139V.

Initially all the digits of the present value will be flashing and the decimal point position will be illuminated. This is to indicate that initially the 'multiplier' must be selected.

Press ↓↑ to change the decimal point position.

Press >> to accept the decimal point position. The Digit Edit screen appears.



Digit Edit

Set the display to read the value of the PT Secondary voltage, as described in Section 3.2 Number Entry Procedure.

After the last digit has been set and accepted, the Confirmation screen will appear.

Confirmation

Press >> to accept the displayed value. Depending on the model, this may take you out of the Set-up screens and back to the last selected Display screen.

Press ↓↑ to return to the Decimal Point screen.

The secondary value may only be set to values within the range defined by the factory voltage build option. These nominal rms input voltages are as shown in the relevant measurement transducer specification (see separate document for two-part products or Section 4.2.1 Inputs for combined products).

3.8 Demand Integration Time

0240	0340	0440	0640	1000	1540

This screen is used to set the period over which current and power readings are integrated (see Section 1.4 Demand). The value displayed represents time in minutes.

Value

To accept the displayed Demand Integration Time, press >>. The next Set-up screen will appear (Section 3.9 Resets)

To change the Demand Integration Time, press ↓↑ and use this key to scroll through the available values.

Select the required value and press >> to accept it. The Confirmation screen will appear.

Confirmation

Press >> to accept the displayed value . The next Set-up screen will appear (Section 3.9 Resets).

Press ↓↑ to return to the Value screen and change the value.

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3.9 Resets

0240	0340	0440	0640	1000	1540

The following screens allow resetting of the Energy and Demand readings individually or altogether.

Resetting the cumulative Energy (h) resets both Active and Reactive Energy.

Resetting Demand (d) resets:

- Active Power Demand
- Current Demand
- Maximum Active Power Demand
- Maximum Current Demand

Reset (None)

Press >> to move on to the next Set-up screen without resetting any readings.

To reset one or more readings press ↓↑. The first reset screen (All) will appear.

Reset All

Use ↓↑ to scroll through the parameters that can be reset:

h Active and reactive energy

d Demands and maximum demands

None – no reset

All – h and d combined.

Select the option required and press >> to confirm your selection. The appropriate confirmation screen will appear.

(The confirmation screen will not appear if None has been selected.)

Confirmation

Press ↓↑ to return to the Reset screen.

Press >> to reset the selected reading(s). The next screen will appear.

3.10 Pulsed Output, Pulse Duration

0240	0340	0440	0640	1000	1540	Option

This applies to the Relay Pulsed Output option only. Units with this option provide pulses to indicate power consumption (kWh). See Section 1.6 pulse output option.

This screen allows the user to set the duration of the relay output pulse. The value displayed represents the pulse duration in milliseconds (ms). On a two part DIS 1540/Integra 1560, this screen will set the pulse duration for the Kvarh pulse relay (where fitted) also.

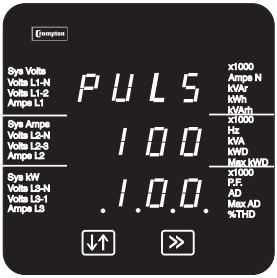
Edit

To retain the current setting, press >>. The next Set-up screen will appear.

To change the pulse duration, press ↓↑.

Use the ↓↑ key to scroll through the available values of 60, 100 and 200.

Select the value required and press >> to confirm your selection. The confirmation screen will appear.



Confirmation

To change the value again, press ↓↑. The Edit screen will reappear.

To accept the displayed pulse duration, press >>. The next screen will appear. Depending on the model, this may take you out of the Set-up screens and back to the last selected Display screen.

3.11 Pulse Rate

0240	0340	0440	0640	1000	1540	Option

This applies to the Relay Pulsed Output option only. Units with this option provide pulses to indicate power consumption (kWh).

This screen allows setting of the kWh pulse rate divisor. On a two part DIS 1540/Integra 1560, this screen will set the pulse rate for the kvarh pulse relay (where fitted) also. By default, the unit produces one pulse per kWh. Changing this divisor changes the output pulse rate, as follows:

Divisor	One pulse per:
1	1 kWh
10	10 kWh
100	100 kWh
1000	1000 kWh (DIS1540 with 1560/1580 only)

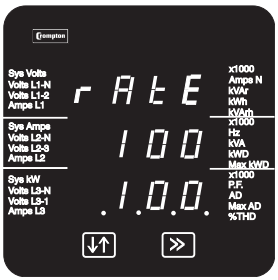
Press >> to accept the currently displayed value. The next Set-up screen will then appear.

Edit

To change the pulse rate divisor, press ↓↑.

Use the ↓↑ key to scroll the value through the available values 1, 10, 100, 1,000. If the maximum power is greater than 3.6 megawatts, the range of divisors will be restricted to force an upper limit to the number of pulses/hour of 3600.

Select the required divisor and press >> to confirm your selection. The Confirmation screen will appear.



Confirmation

To change the value again, press ↓↑. The Edit screen will reappear.

To accept the displayed value, press >>. The next Set-up screen will appear.

3.12 RS485 Baud Rate

0240	0340	0440	0640	1000	1540	Option

Use this screen to set the Baud Rate of the RS485 Modbus/JC NII port. The values displayed are in kbaud.

Where the transducer unit may be separate from the display unit, the transducer has two Modbus ports, at least one of which may be used for communicating with a display. The RS485 Baud Rate option only sets the Baud Rate for a port that is not communicating with a display unit. The port characteristics for communication with a display are preset. If the JC NII protocol is to be used, the baud rate must be set to 9.6.

If a display is detected on an RS485 port at start-up, any user settings for that port will be ignored.

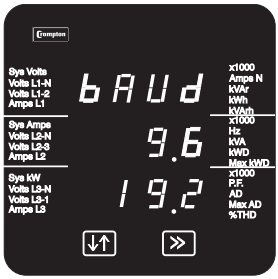
Edit

Press >> to accept the currently displayed value. The next Set-up screen will then appear.

To change the baud rate, press ↓↑.

Use the ↓↑ key to scroll through the available values 2.4, 4.8, 9.6 and 19.2.

Select the required baud rate and press >> to confirm your selection. The Confirmation screen will appear.



Confirmation

Press >> to accept the new setting. The next Set-up screen will appear.

To change the value again, press ↓↑. The Edit screen will reappear.

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3.13 RS485 Parity Selection

0240	0340	0440	0640	1000	1540	Option

This screen allows setting of the parity and number of stop bits of the RS485 Modbus/JC II port.

Where the transducer unit is separate from the display unit, the transducer has two Modbus ports, one of which may be used for communicating with a display. The RS485 Parity Selection option only sets the parity for a port that is not communicating with a display unit. The port characteristics for communication with a display are preset.

If the JC NII protocol is to be used, this parameter must be set to No parity and One stop bit.

Edit

Press >> to accept the currently displayed value. The next Set-up screen will then appear.

To change the parity press ↓↑.

Use the ↓↑ key to scroll through the available values:

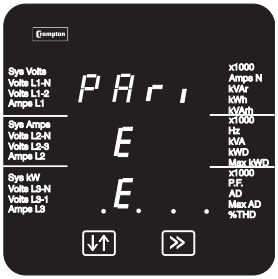
odd – odd parity with one stop bit

E – even parity with one stop bit

no 1 – no parity one stop bit,

no 2 – no parity two stop bits.

Select the required setting and press >> to confirm your selection. The Confirmation screen will appear.



Confirmation

Press >> to accept the new setting. The next Set-up screen will appear.

Press ↓↑ to return to the Edit screen.

3.14 RS485 Modbus Address

0240	0340	0440	0640	1000	1540	Option

This screen allows setting of the Modbus/JC NII device address for the instrument.

Where the transducer unit is separate from the display unit, the transducer has two RS485 ports, one of which may be used for communicating with a display. The Address option only sets the address for a port that is not communicating with a display unit. The port characteristics for communication with a display are preset.

Edit

Press >> to accept the currently displayed value. The next Set-up screen will then appear.

To change the address, press ↓↑.

Set the three-digit address using the method described in Section 3.2 Number Entry Procedure. The range of the allowable addresses is 1 to 247. The range of selectable digits is restricted so that no higher number can be set.

Press >> to confirm your selection. The Confirmation screen will appear.

Confirmation

If the new address is correct, press >>. Depending on the model, this may take you out of the Set-up screens and back to the last selected Display screen.

If the new address is not correct, press ↓↑ to return to the Edit screen.

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3.15 Analogue Output Set Up

0240	0340	0440	0640	1000	1540	Option

This is an option on Models 1540 that have separate (1560 or 1580) transducers.

3.15.1 Introduction

This applies to the analogue output option only, allowing the parameter to be selected, and the upper and lower limits adjusted, for either one or two channels.

For each analogue output fitted, provision is made for five values to be user selected. These are:

- **A1r** – Parameter, from Table 2. This is the measured input that is to be represented by the analogue output, for example, Watts or Frequency.
- **A1rt** – Reading Top. This is the value of the electrical parameter that will cause the analogue output to produce 'Output Top'.
- **A1rb** – Reading Bottom. This is the value of the electrical parameter that will cause the analogue output to produce 'Output Bottom'.
- **A1ot** – Output Top. This is the value of output that will be reached when the measured electrical parameter is at the reading top value.
- **A1ob** – Output Bottom. This is the value of output that will be reached when the measured electrical parameter is at the reading bottom value.

To aid understanding, a simple example is shown in Section 3.15.2.

3.15.1.1 Second Channel

The screens following show the set-up for the first analogue channel. Set-up of the second analogue output is identical except that screens show 'A2' instead of 'A1', i.e. **A2r, A2rt, A2rb, A2ot, A2ob**.

At the end of the set up for the second analogue output pressing >> will exit the set up system and enter the display mode.

3.15.1.2 Reverse Operation

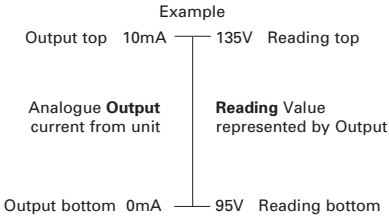
It is possible to set reading top below reading bottom. In the example of Section 3.15.2, setting reading top to 95 volts and reading bottom to 135 volts would cause the output current to decrease from 20mA to 4mA as the measured voltage increased from 95 to 135 volts.

3.15.1.3 Reduced output range

Note that if the output values are adjusted to reduce output range, accuracy may be degraded. For example, if a 0-20mA capable output is set to operate over 0-1mA, then the specified accuracy will be degraded by a factor of 20.

3.15.2 Analogue Output Scaling Example

In this example, the Integra has an output current range of 0 to 10mA and it is required that this output range represents a reading range of 95 to 135V.



3.15.2.1 Reading (A1r or A2r)

The measured electrical parameter that the analogue output will represent.
Example: **Volts Ave** (Average Voltage)

As shown in Table 2, any continuously variable parameter (volts, amps, watts etc) can be selected for output as an analogue value. The table also shows those values that may be signed (where the value may go negative).

3.15.2.2 Reading Top (A1rt or A2rt)

This is the value of the electrical parameter that will cause the analogue output to produce 'Output Top'.

Example: **135 volts**.

3.15.2.3 Reading Bottom (A1rb or A2rb)

This is the value of the electrical parameter that will cause the analogue output to produce 'Output Bottom'.

Example: **95 volts**.

This value may be set to any value between zero and 120% of nominal. (Or between –120% and +120% of values that may be signed for example VAr)

3.15.2.4 Output

The two Output values specify the analogue current outputs that will represent the top and bottom Reading values. They are included to allow additional versatility where particular requirements prevail or to convert a 0-20mA output to 4-20mA. However it is suggested that, in most other cases, these values should be set to the limits that the hardware can cover. The range of the analogue output(s) for the unit is marked on the product label.

3.15.2.5 Output Top (A1ot or A2ot)

This is the value of output that will be reached when the measured electrical parameter is at the reading top value.

Example: **10mA**.

3.15.2.6 Output Bottom (A1ob or A2ob)

This is the value of output that will be reached when the measured electrical parameter is at the reading bottom value.

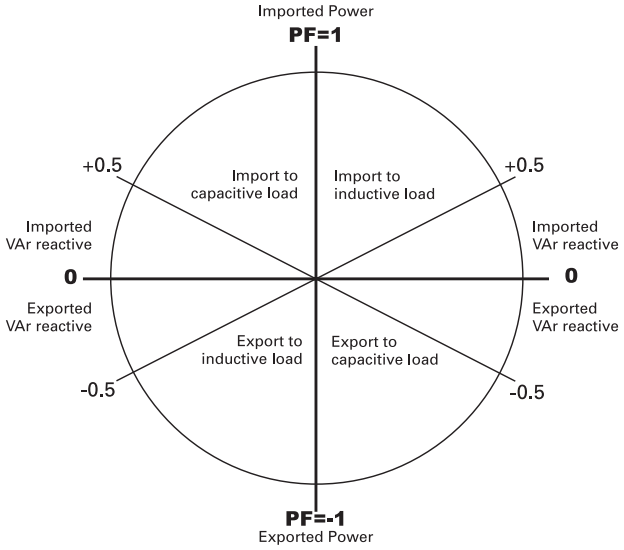
Example: **0mA**

3.15.2.7 Summary

In the above example, the analogue output will be 0 mA when the average voltage is 95 volts, 5 mA at 115 volts and 10 mA at 135 volts.

3.15.3 Power Factor

When analogue output current is used to represent power factor, it can indicate the power factor for an inductive or capacitive load on imported or exported power. This can be shown in two dimensions as follows:



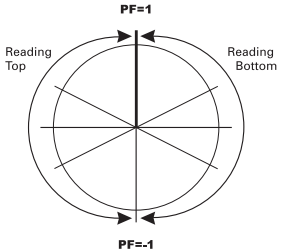
Power factor

The polarity of the power factor reading indicates the direction of power flow:

Positive	PF relates to imported power
Negative	PF relates exported power.

This assumes that the unit is connected for a predominantly 'import' application. See Installation sheet for further details.

When setting up the analogue output for a power factor reading, the Reading Top value must be in one of the left-hand quadrants and the Reading Bottom value must be in one of the right-hand quadrants.

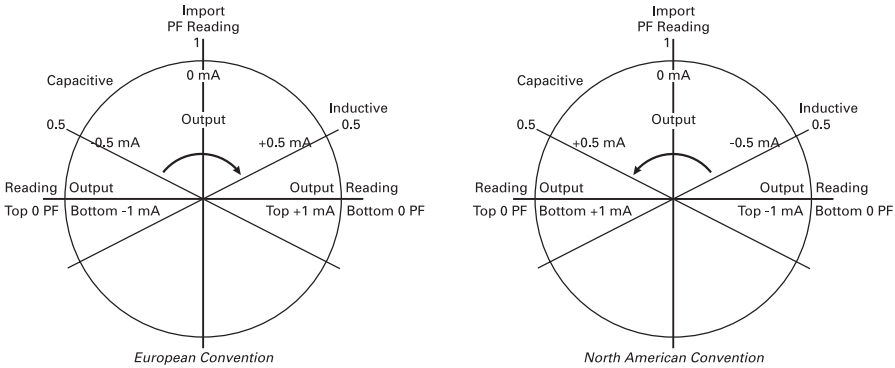


Hence, if the Reading Top value is set to –0.5, this will be a power factor of 0.5 for power exported to an **inductive** load (bottom **left-hand** quadrant). Conversely, the Reading Bottom value must be in one of the two right-hand quadrants. If the Reading Bottom value is set to –0.5, this will be a power factor of 0.5 for power exported to a capacitive load (bottom **right-hand** quadrant). Thus a power factor of +1 (for true power imported to a resistive load) is always included in the analogue output range.

In specifying the Output Top and Output Bottom values, there are two conventions – one for European areas of influence and one for North American areas. The two conventions are:

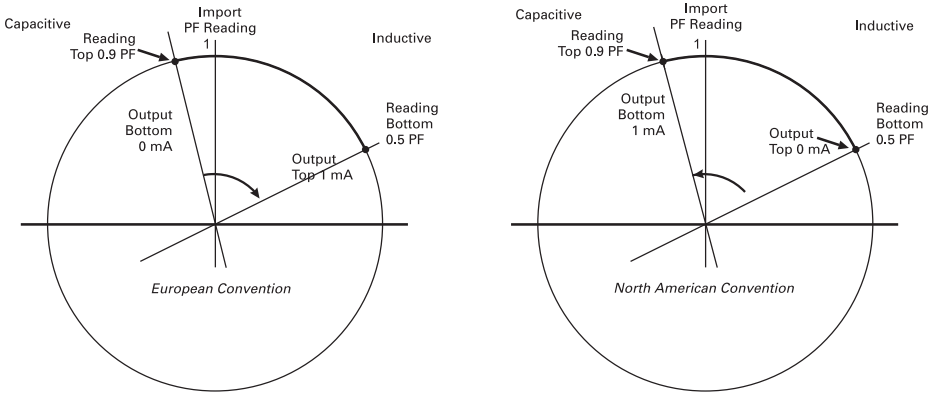
Europe	Output Top greater or more positive than Output Bottom.
USA	Output Top less or more negative than Output Bottom.

The examples below show cases where power is only imported and the load may be either capacitive or inductive. The Reading Top and Reading Bottom values of zero ensure that the whole range of possible (import) power factor readings is covered. The unit in the left-hand example has an analogue output range of +1 to –1 mA and, since the Output Top value (+1 mA) is more positive than the Output Bottom value (-1 mA), this arrangement complies with the European convention. The right-hand example shows the North American convention.



Symmetrical full-range, import only

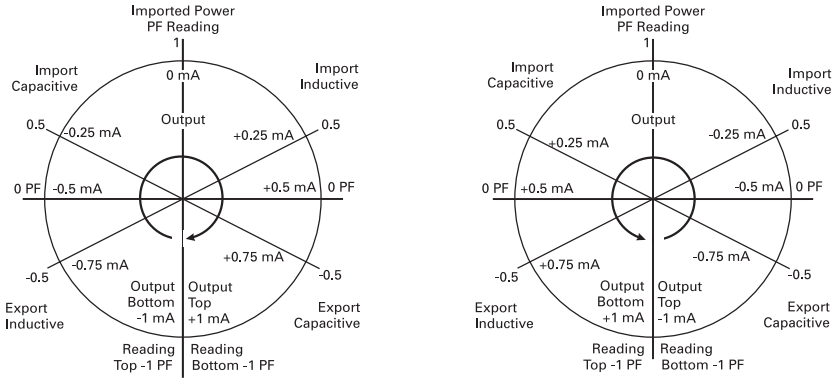
In the above symmetrical arrangement, 0 mA corresponds to unity power factor. This is not the case with the following asymmetrical arrangement.



Asymmetrical, import only, mainly inductive

In the example above, the unit has an analogue output range of 0 to 1 mA, all power is imported and the load is inductive. The 1 mA Output range covers a reading power factor range of 0.6, from 0.9 capacitive to 0.5 inductive. The capacitive overlap is provided in case of over-compensation of power factor. The Output to Reading correlation is as follows:

Reading	**European Convention Output**	**North American Convention Output**
0.9 PF cap.	0 mA	1 mA
1 PF	0.167 mA	0.833 mA
0.9 PF ind.	0.333 mA	0.667 mA
0.8 PF ind.	0.500 mA	0.500 mA
0.7 PF ind.	0.667 mA	0.333 mA
0.6 PF ind.	0.833 mA	0.167 mA
0.5 PF ind.	1 mA	0 mA

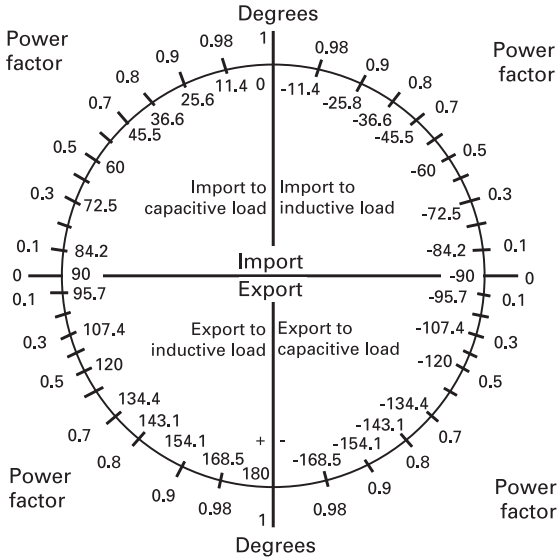


Symmetrical full-range import/export

In this example, the unit is set to represent the full range of inductive and capacitive loads on imported and exported power. The unit has an analogue output range of –1 to +1 mA. Both Reading Top and Reading Bottom are set to –1 power factor.

3.15.4 Phase Angle

The Phase Angle analogue outputs are treated in a similar manner to Power Factor, with values specified in degrees. The following figure shows the relationship between phase angle in degrees and power factor.



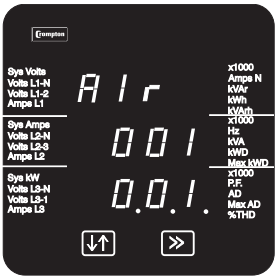
3.15.5 Parameters available for analogue outputs

Table 2 Analogue output parameter selection

Parameter Number	Parameter	3 Ø 4 wire	3 Ø 3 wire	1 Ø 3 wire	1 Ø 2 wire	+/-
1	Volts 1 (L1 – N 4W or L1 – L2 3W)	✓	✓	✓	✓	
2	Volts 2 (L2 – N 4W or L2 – L3 3W)	✓	✓	✓		
3	Volts 3 (L3 – N 4W or L3 – L1 3W)	✓	✓			
4	Current 1	✓	✓	✓	✓	
5	Current 2	✓	✓	✓		
6	Current 3	✓	✓			
7	Watts Phase 1	✓		✓	✓	✓
8	Watts Phase 2	✓		✓		✓
9	Watts Phase 3	✓				✓
10	VA Phase 1	✓		✓	✓	
11	VA Phase 2	✓		✓		
12	VA Phase 3	✓				
13	VAr Phase 1	✓		✓	✓	✓
14	VAr Phase 2	✓		✓		✓
15	VAr Phase 3	✓				✓
16	Power Factor Phase 1	✓		✓	✓	✓
17	Power Factor Phase 2	✓		✓		✓
18	Power Factor Phase 3	✓				✓
19	Phase Angle Phase 1	✓		✓	✓	✓
20	Phase Angle Phase 2	✓		✓		✓
21	Phase Angle Phase 3	✓				✓
22	Volts Ave	✓	✓	✓	✓	
24	Current Ave	✓	✓	✓	✓	
25	Current Sum	✓	✓	✓	✓	
27	Watts Sum	✓	✓	✓	✓	✓
29	VA Sum	✓	✓	✓	✓	
31	VAr Sum	✓	✓	✓	✓	✓
32	Power Factor Ave	✓	✓	✓	✓	✓
34	Average Phase Angle	✓	✓	✓	✓	✓
36	Frequency	✓	✓	✓	✓	
43	W Demand Import	✓	✓	✓	✓	
44	W Max. Demand Import	✓	✓	✓	✓	
53	A Demand	✓	✓	✓	✓	
54	A Max. Demand	✓	✓	✓	✓	
101	V L1-L2 (calculated)	✓		✓		
102	V L2-L3 (calculated)	✓				

Parameter Number	Parameter	3 Ø 4 wire	3 Ø 3 wire	1 Ø 3 wire	1 Ø 2 wire	+/-
103	V L3-L1 (calculated)	✓				
104	Average Line to Line Volts	✓		✓		
113	Neutral Current	✓		✓	✓	
118	THD Volts 1	✓	✓	✓	✓	
119	THD Volts 2	✓	✓	✓		
120	THD Volts 3	✓	✓			
121	THD Current 1	✓	✓	✓	✓	
122	THD Current 2	✓	✓	✓		
123	THD Current 3	✓	✓			
125	THD Voltage Mean	✓	✓	✓	✓	
126	THD Current Mean	✓	✓	✓	✓	

Parameter Selection



Confirmation

3.15.6 Reading (Parameter Selection) - A1r or A2r

Use this screen to choose the parameter that the analogue Output current will represent. The number displayed on the screen is the Parameter Number shown in Table 2.

If the displayed Parameter Number is already correct, press >> to move on to the next Set-up screen.

To change the Parameter Number, press ↓↑ and set the three-digit number using the method described in Section 3.2 Number Entry Procedure.

Press >> to confirm your selection. The Confirmation screen will appear.

If the new Parameter Number is correct, press >>. The next Set-up screen will appear.

If not, press ↓↑. You will be returned to the Parameter Selection screen.

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3.15.7 Reading Top – A1rt or A2rt

The top reading is limited to 120% of the nominal maximum value of the parameter. For example, a 230V nominal can be adjusted from 0 to 276V. The minimum is zero or –120% if the parameter is signed.

Sign edit

This screen allows a negative value to be specified as the top reading. It will only be available if the parameter selected on the previous screen can be negative. For these parameters, the +/- column of Table 2 has a tick (✓).

To accept the current value ('-' for negative, no symbol for positive), press >> to advance to the Alrb screen.

Use ↓↑ to select the '-' sign for a negative Reading or no symbol for a positive Reading.

Press >> to accept the current sign and advance to the next screen.

Decimal Point Position

Use this screen to set the position of the decimal point. This screen will not appear when the selected parameter is frequency, as there is no choice of decimal point position.

Pressing the ↓↑ key will advance the decimal point position to the right, illuminating the x1000 indicator as necessary and wrapping the decimal point position when the highest available position for the currently selected reading has been exceeded. (Maximum resolution is 3 digits of the metered value.)

Select the required decimal point position and press >> to confirm your selection. The next screen will appear.

Value Entry

Use this screen to set the value of the Reading Top

Set the three-digit Reading Top value using the method described in Section 3.2 Number Entry Procedure.

Press >> to confirm your selection. The Confirmation screen will appear.

Confirmation

Press >> to accept the displayed Reading Top value, The next Set-up screen will appear.

Press ↓↑ to return to the Edit screen.

3.15.8 Reading Bottom - A1rb or A2rb

Use these screens to specify the minimum or most negative value for the Reading Bottom value.

The method of setting the Reading Bottom screens is the same as for setting the Reading Top screens, as described in Section 3.15.7. The Reading Bottom screens show A1rb (or A2rb for the Analogue output 2) on the top line.

3.15.9 Output Top – A1ot or A2ot

Use these screens to set the maximum analogue output current (in mA). This current will represent the highest reading value. You cannot specify a greater current than the actual value that the unit can supply, e.g. 1 mA.

The method of setting the Output Top screens is the same as for setting the Reading Top screens, as described in Section 3.15.7. The Output Top screens show A1ot (or A2ot for the Analogue output 2) on the top line.

3.15.10 Output Bottom – A1ob or A2ob

Use these screens to set the minimum or most negative analogue output current (in mA). This current will represent the lowest or most negative reading value. The current cannot be set to a value that exceeds the actual capability of the unit, e.g. it cannot be set it to –10 mA if the unit can only handle –1 mA.

The method of setting the Output Bottom screens is the same as for setting the Reading Top screens, as described in Section 3.15.7. These screens show A1ob (or A2ob for Analogue output 2) on the top line.

4 Specification

The parameters listed in this section apply only to those models that can measure those parameters.

4.1 Display Only Versions

4.1.1 Input

RS485	Dedicated to Crompton Integra transducers

4.1.2 Auxiliary Power Supply

The unit can be powered from an auxiliary a.c. or d.c. supply that is separate from the metered supply. Versions of the unit are available to suit 100-250V 45-65 Hz a.c./d.c. and 12-48V d.c supplies.

4.1.2.1 High Voltage version

Standard nominal supply voltages	100 - 250V a.c. nominal ± 15% (85V a.c. absolute minimum to 287V a.c. absolute maximum) or 100 - 250V d.c. nominal -15%, +25% (85V d.c. absolute minimum to 312V d.c. absolute maximum)
A.C. supply frequency range	45 to 66 Hz or 360 to 440 Hz (Model 0440)
A.C. supply burden	4VA approx.

4.1.2.2 Low Voltage version

D.C.supply	12 - 48V d.c. -15% + 25% (10.2V d.c. absolute minimum to 60V d.c. absolute maximum)
D.C. supply burden	4VA approx.

4.1.3 EMC Standards

EMC Immunity	EN61326 for Industrial Locations to performance criterion A
EMC Emissions	EN61326 to Class A - Industrial

4.1.4 Safety

IEC1010-1 (BSEN 61010-1) Permanently connected use, Normal Condition Installation category III, pollution degree 2, Basic Insulation 300V RMS maximum. Auxilary circuits (12-48V auxiliary, communications, relay and analogue outputs, where applicable) are separated from metering inputs and 100-250V auxiliary circuits by at least basic insulation. Such auxiliary circuit terminals are only suitable for connection to equipment which has no user accessible live parts. The insulation for such auxiliary circuits must be rated for the highest voltage connected to the instrument and suitable for single fault condition. The connection at the remote end of such auxiliary circuits should not be accessible in normal use. Depending on application, equipment connected to auxiliary circuits may vary widely. The choice of connected equipment or combination of equipment should not diminish the level of user protection specified.

4.1.5 Insulation

Dielectric voltage withstand test	3.25kV RMS 50 Hz for 1 minute between all electrical circuits

4.1.6 Environmental

Operating temperature	-10 to +60°C
Storage temperature	-20 to +85°C
Relative humidity	0 .. 95% non condensing
Shock	30g in 3 planes
Vibration	10 to 15 Hz @ 1.5 mm peak-peak 15 to 150 Hz @ 1.0g
Enclosure integrity (front face only)	IP54

4.1.7 Enclosure

Style	ANSI C39.1
Material	Polycarbonate front and base, steel case
Terminals	Screw clamp style

4.2 Display/Transducer Combined 0240, 0340, 0440, 0640

For Model 1000 and 1540 specification, refer to Section 4.3.

4.2.1 Inputs

Three phase three wire voltage range:	ELV	100 - 120V L-L
	LOV	121 - 240V L-L
	MIV	241 - 480V L-L
	HIV	481 - 600V L-L
Three phase four wire voltage range:	ELV	100 - 120V L-L (57.7 - 70V L-N)

LOV	121 - 240V L-L (70.1 - 139V L-N)
MIV	241 - 480V L-L (140 - 277V L-N)
HIV	481 - 600V L-L (277 - 346V L-N)

(Voltage range is defined by factory build option.)

Nominal input voltage (a.c. rms)	57.7 to 346V L-N 100 to 600V L-L
System PT/VT primary values	1V to 400 kV
Max continuous input voltage	120% of nominal (up to 720 V max.)
Max short duration input voltage	Twice nominal (1s application repeated 10 times at 10s intervals)
Nominal input voltage burden	0.2 VA approx. per phase
Nominal input current	1 or 5 A a.c. rms
System CT primary values	Standard values up to 9999 Amps (5 A secondaries) (1 A on application)
Max continuous input current	120% of nominal
Max short duration current input	20 times nominal (1s application repeated 5 times at 5 min intervals)
Nominal input current burden	0.6 VA approx. per phase

4.2.2 Auxiliary Power Supply

The unit can be powered from an auxiliary a.c. or d.c. supply that is separate from the metered supply. Versions of the unit are available to suit 100-200V 45-65 Hz a.c./d.c. and 12-48V d.c supplies.

4.2.2.1 High Voltage version

Standard supply voltage	100 to 250V a.c. nominal ±15% (85V a.c. absolute minimum to 287V a.c. absolute maximum) or 100V to 250V d.c. nominal +25%, -15% (85V d.c. absolute minimum to 312V d.c. absolute maximum)
a.c. supply frequency range	45 to 66 Hz or 360 to 440 Hz (Model 0440)
a.c. supply burden	3W

4.2.2.2 Low Voltage version

d.c.supply	12 to 48V d.c.. nominal +25%, -15% (10.2V d.c. absolute minimum to 60V d.c. absolute maximum)
d.c. supply burden	3W

4.2.3 Measuring Ranges

Values of measured quantities for which errors are defined.

Voltage	70 .. 120% of nominal
Current	5 .. 120% of nominal
Frequency	45 .. 66 Hz, 360 .. 440 Hz (Model 0440) Crest values of voltage and current must remain within 168% of nominal maximum rms values

4.2.4 Accuracy

Voltage	0.4% of reading ±0.1% of range 1% of range maximum for Model 0440
Current	0.4% of reading ±0.1% of range 1% of range maximum for Model 0440
Frequency (not 0340)	0.15% of mid frequency 1% of mid frequency for Model 0440
Temperature coefficient	0.013%/°C typical
Response time to step input	1.5 seconds approx.
Screen update time	0.5 second approx.

4.2.5 Reference conditions of influence quantities

Values that quantities which affect measurement errors to a minor degree have to be for the intrinsic (headline) errors for measured quantities to apply.

Ambient temperature	23°C
Input frequency	50 or 60 Hz 2%
Input waveform Sinusoidal	(distortion factor 0.005)
Auxiliary supply voltage Nominal	1%
Auxiliary supply frequency Nominal	1%
Auxiliary supply distortion factor	0.05
Magnetic field of external origin	Terrestrial flux

4.2.6 EMC Standards

EMC Immunity EN61326 for Industrial Locations to performance criterion A
EMC Emissions EN61326 to Class B - Domestic

4.2.7 Safety

IEC1010-1 (BSEN 61010-1) Permanently connected use, Normal Condition Installation category III, pollution degree 2, Basic Insulation 720V RMS maximum. Auxiliary circuits (12-48V auxuliary, communications, relay and analogue outputs, where applicable) are separated from metering inputs and 100-250V auxiliary circuits by at least basic insulation. Such auxiliary circuit terminals are only suitable for connection to equipment which has no user accessible live parts. The insulation for such auxiliary circuits must be rated for the highest voltage connected to the instrument and suitable for single fault condition. The connection at the remote end of such auxiliary circuits should not be accessible in normal use. Depending on application, equipment connected to auxiliary circuits may vary widely. The choice of connected equipment or combination of equipment should not diminish the level of user protection specified.

4.2.8 Insulation

Dielectric voltage withstand test 3.25kV RMS 50Hz for 1 minute between all isolated electrical circuits

4.2.9 Environmental

Operating temperature	-20 to +70°C
Storage temperature	-20 to +80°C
Relative humidity	0 .. 95% non condensing
Shock	30g in 3 planes
Vibration	10 to 15 Hz @ 1.5 mm peak-peak 15 to 150 Hz @ 1.0g
Enclosure integrity (front face only)	IP54
Harmonic distortion	max 50% THD up to 15th harmonic

4.2.10 Enclosure

Style	ANSI C39.1
Material	Polycarbonate front and base, steel case
Terminals	6-32 UNC slotted barrier type
Weight	1.3kg

4.3 Display/Tranducer Combined 1000 and 1540

See section 4.3.16 for specifications particular to the 1540

4.3.1 Inputs

Nominal input voltage (a.c. rms)	57.7 to 600V L-N (single phase) 100 to 600V L-L (3 wire) 57.7 to 346V L-N (4 wire)
System PT/VT primary values	1V to 400KV

Max continuous input voltage	120% of nominal (up to 720V max.)
Max short duration input voltage	2*nominal (1s application repeated 10 times at 10s intervals)
Nominal input voltage burden	0.2VA approx. per phase
Nominal input current	1 or 5A a.c. rms
System CT primary values	Std. values up to 4kA (1 or 5 Amp secondaries)
Max continuous input current	120% of nominal
Max short duration current input	20*nominal (1s application repeated 5 times at 5 min intervals)
Nominal input current burden	0.6VA approx. per phase

4.3.2 Auxiliary Power Supply

The unit can be powered from an auxiliary a.c. or d.c. supply that is separate from the metered supply. Versions of the unit are available to suit 100-200V 45-65 Hz a.c./d.c. and 12-48V d.c supplies.

Standard supply voltage	100 to 250V a.c. nominal ±15% (85V a.c. absolute minimum to 287V a.c. absolute maximum) or 100V to 250V d.c. nominal +25%, -15% (85V d.c. absolute minimum to 312V d.c. absolute maximum)
a.c. supply frequency range	45 to 66 Hz or 360 to 440 Hz (Model 0440)
a.c. supply burden	3W
d.c.supply	12 to 48V d.c.. nominal +25%, -15% (10.2V d.c. absolute minimum to 60V d.c. absolute maximum)
d.c. supply burden	3W

4.3.3 Accuracy

Voltage	0.4% of reading ±0.1% of range
Current	0.4% of reading ±0.1% of range
Neutral current	4% of range
Frequency	0.15% of mid frequency
Power factor	1% of Unity
Active power (W)	0.9% of reading ±0.1% of range
Reactive power (VAr)	1.9% of reading ±0.1% of range
Apparent power (VA)	0.9% of reading ±0.1% of range
Active energy (W.h)	1 Class (IEC 1036, Active PF 0.8-1-0.8 importing)
Reactive energy (VAr.h)	2%, Reactive PF 0.8-1-0.8 importing)
Temperature coefficient	0.013%/°C typical
Response time to step input	1.5 seconds approx.
Error change due to variation of an influence quantity in the manner described in section 6	Twice the error allowed for the reference condition applied in the test.

of IEC688:1992

Error in measurement when a measurand is within its measuring range, but outside its reference range.	Twice the error allowed at the end of the reference range adjacent to the section of the measuring range where the measurand is currently operating or being tested.

4.3.4 Reference conditions

Reference conditions of measurands and, where applicable, components of the measurand

Values of measured quantities, and of components of measured quantities, where the intrinsic (headline) errors for the measured quantities apply.

Voltage	50 .. 100% of nominal
Current	10 .. 100% of nominal
Frequency	Nominal ±10%
Active power (Watt)	10 .. 100% of nominal
Voltage	Nominal ±2%
Current	10 .. 100% of nominal
Active power factor	1 .. 0.8 leading or lagging
Reactive power (VAr)	10 .. 100% of nominal
Voltage	Nominal ±2%
Current	10 .. 100% of nominal
Reactive power factor	1 .. 0.8 leading or lagging
Apparent Power (VA)	10 .. 100% of nominal
Voltage	Nominal ±2%
Current	10 .. 100% of nominal
Power factor	1 .. 0.8 leading or lagging
Voltage	Nominal ±2%
Current	40 .. 100% of nominal

4.3.5 Reference conditions of influence quantities

Values that quantities which affect measurement errors to a minor degree have to be for the intrinsic (headline) errors for measured quantities to apply.

Ambient temperature	23°C
Input frequency	50 or 60 Hz ±2%
Input waveform	Sinusoidal (distortion factor 0.005)
Auxiliary supply voltage	Nominal ±1%
Auxiliary supply frequency	Nominal ±1%
Auxiliary supply distortion factor	0.05
Magnetic field of external origin	Terrestrial flux

4.3.6 Nominal range of use of influence quantities for measurands

Values of quantities which affect measurement errors to a minor degree for which the magnitude of the measurement error is defined in this specification.

Voltage	50 .. 120% of nominal
Current	5 .. 120% of nominal
Frequency	Nominal ±10%
Power factor (active/reactive as appropriate)	0.5 lagging .. 1 .. 0.8 leading ,importing
Temperature	-20°C to +70°C
Input waveform distortion	20% 3rd Harmonic distortion
Auxiliary supply voltage	Nominal ±10%
Auxiliary supply frequency	Nominal ±10%
Magnetic field of external origin	400A/m
	Crest values of voltage and current must remain within 168% of nominal maximum rms values

4.3.7 Functional ranges

The functional ranges of measurands and of influence quantities for measurands

Values of measured quantities, components of measured quantities, and quantities which affect measurement errors to a minor degree, for which the product gives meaningful readings.

Voltage	5 .. 120% of nominal (below 5% of nominal voltage, current indication is only approximate)
Current	0 .. 120% of nominal (2 .. 120% of nominal for Power Factor)
Frequency	45 .. 66 Hz
Power Factor	1 .. 0 leading or lagging, importing (active/reactive as appropriate)
Temperature	-20°C to +70°C
Active power (Watt)	0 .. 120% of nominal, 360 MW Max.
Reactive power (VAr)	0 .. 120% of nominal, 360 MVAr Max.
Apparent power (VA)	0 .. 120% of nominal, 360 MVA Max.

4.3.8 Screen

Update	0.5 second approx.

4.3.9 Standards

Terms, Definitions and Test Methods	IEC688 (BSEN 60688) IEC1036 (BSEN 61036)
EMC	IEC 61326

4.3.10 Safety

IEC1010-1 (BSEN 61010-1) Permanently connected use, Normal Condition Installation category III, pollution degree 2, Basic Insulation 720V RMS maximum. Auxiliary circuits (12-48V auxuliary, communications, relay and analogue outputs, where applicable) are separated from metering inputs and 100-250V auxiliary circuits by at least basic insulation. Such auxiliary circuit terminals are only suitable for connection to equipment which has no user accessible live parts. The insulation for such auxiliary circuits must be rated for the highest voltage connected to the instrument and suitable for single fault condition. The connection at the remote end of such auxiliary circuits should not be accessible in normal use. Depending on application, equipment connected to auxiliary circuits may vary widely. The choice of connected equipment or combination of equipment should not diminish the level of user protection specified.

4.3.11 Insulation

Dielectric voltage withstand test 3.25kV RMS 50Hz for 1 minute between all isolated electrical circuits

4.3.12 Environmental

Operating temperature	-20°C to +70°C
Storage temperature	-20°C to +80°C
Relative humidity	0 .. 95% non condensing
Warm up time	1 minute
Shock	30g in 3 planes
Vibration	10 to 15 Hz @ 1.5 mm peak-peak 15 to 150 Hz @ 1.0g
Enclosure code (front)	IP54
Harmonic distortion	max 50% THD up to 15th harmonic

4.3.13 Enclosure

Style	ANSI C39.1 or JIS C-1102
Material	Polycarbonate Front, Steel case
Terminals	6-32 UNC slotted barrier style.
Weight	1.3kg

4.3.14 Serial Communications Option

Protocol	MODBUS (RS485)
Baud rate	19200, 9600, 4800 or 2400 (programmable)
Parity	Odd or Even, with 1 stop bit, or None with 1 or 2 stop bits.

4.3.15 Active Energy Pulsed Output Option

Rated	SPNO, 100V dc, 0.5A Max.
Default pulse rate	1 per kWhr
Pulse rate divisors	1 10 (yielding 1 pulse per 10 kWhr) 100 (yielding 1 pulse per 100 kWhr)
Pulse duration	60ms, 100ms or 200ms, 3600 Pulses per hour max

4.3.16 Integra 1540 Only

Measuring Range: Total Harmonic Distortion:	Up to 15th Harmonic 0%-50%
Accuracy:	Total Harmonic Distortion 1%
Reference conditions of measurands:	Voltage: 60% to 100% of nominal for THD
Reference conditions of measurands:	Total Harmonic Distortion: 20% to 100% of nominal for THD
Reference conditions of measurands:	Total Harmonic Distortion: 0-30%

5 Basis of measurement and calculations

Reactive and Apparent Power

Active powers are calculated directly by multiplication of voltage and current. Reactive powers are calculated using frequency corrected quarter phase time delay method. Apparent power is calculated as the square root of sum of squares of active and reactive powers. For 4 wire products, overall powers are the sum of the per phase powers. For 3 phase 3 wire products, the "two wattmeter" method is used for overall powers.

Energy resolution

Cumulative energy counts are reported using the standard IEEE floating point format. Reported energy values in excess of 16MWh may show a small non cumulative error due to the limitations of the number format. Internally the count is maintained with greater precision. The reporting error is less than 1 part per million and will be automatically corrected when the count increases.

Power Factor

The magnitude of Per Phase Power Factor is derived from the per phase active power and per phase apparent power. The power factor value sign is set to negative for an inductive load and positive for a capacitive load.

The magnitude of the System Power Factor is derived from the sum of the per phase active power and per phase apparent power. The system power factor value sign is set to negative for an inductive load and positive for a capacitive load. The load type, capacitive or inductive, is determined from the signs of the sums of the relevant active powers and reactive powers. If both signs are the same, then the load is inductive, if the signs are different then the load is capacitive.

The magnitude of the phase angle is the ArcCos of the power factor. It's sign is taken as the opposite of the var's sign.

Maximum Demand

The maximum power consumption of an installation is an important measurement as power utilities often levy related charges. Many utilities use a thermal maximum demand indicator (MDI) to measure this peak power consumption. An MDI averages the power consumed over a number of minutes, such that short surges do not give an artificially high reading.

Integra uses a sliding window algorithm to simulate the characteristics of a thermal MDI instrument, with the demand period being updated every minute.

The demand period can be reset, which allows synchronisation to other equipment. When it is reset, the values in the Demand and Maximum Demand registers are set to zero.

Time Integration Periods can be set to 8, 15, 20 or 30 minutes.

Note: During the initial period when the "sliding window" does not yet contain a full set of readings (i.e. the elapsed time since the demands were last reset or the elapsed time since Integra was switched on is less than the selected demand period) then maximum demands may not be true due to the absence of immediate historical data.

The Time Integration Period can be user set either from the Integra 1540 Display or by using the communications option.

Total Harmonic Distortion (1540 only)

The calculation used for the Total Harmonic Distortion is:

THD = ((RMS of total waveform - RMS of fundamental) / RMS of total waveform) x 100

This is often referred to as THD - R

The figure is limited to the range 0 to 100% and is subject to the 'range of use' limits. The instrument may give erratic or incorrect readings where the THD is very high and the fundamental is essentially suppressed.

For low signal levels the noise contributions from the signal may represent a significant portion of the "RMS of total waveform" and may thus generate unexpectedly high values of THD. To avoid indicating large figures of THD for low signal levels the product will produce a display of 0 (zero).

Typically, display of THD will only produce the 0 (zero) value when the THD calculation has been suppressed due to a low signal level being detected. It should also be noted that spurious signals (for example, switching spikes) if coincident with the waveform sampling period will be included in the "RMS of the total waveform" and will be used in the calculation of THD.

The display of THD may be seen to fluctuate under these conditions.

6 Serial Communications

6.1. RS485 Port – Modbus or JC N2

0240	0340	0440	0640	1000	1540	Option

INTEGRA 1000 and 1540 offer the option of an RS485 communication port for direct connection to SCADA systems. This port can be used for either an RS485 Modbus RTU slave, or as a Johnson Controls N2 protocol slave. Choice of reply protocol is made by the Integra on the basis of the format of request, so that a Modbus request receives a Modbus reply, and an N2 protocol request receives an N2 protocol reply.

6.2 Modbus® Implementation

This section provides basic information for the integration of the product to a Modbus network. If background information or more details of the Integra implementation is required please refer to our "Guide to RS485 Communications and the Modbus Protocol", available on our CD catalogue or from any recognised supplier.

The Modbus, protocol establishes the format for the master's query by placing into it the device address, a function code defining the requested action, any data to be sent, and an error checking field. The slave's response message is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned, and an error-checking field. If an error occurs in receipt of the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send it as it's response. Framing errors receive no response from the Integra.

The electrical interface is 2-wire RS485, via 3 screw terminals. Connection should be made using twisted pair screened cable (Typically 22 gauge Belden 8761 or equivalent). All "A" and "B" connections are daisy chained together. The screens should also be connected to the "Gnd" terminal. To avoid the possibility of loop currents, an Earth connection should be made at only one point on the network.

Line topology may or may not require terminating loads depending on the type and length of cable used. Loop (ring) topology does not require any termination load.

The impedance of the termination load should match the impedance of the cable and be at both ends of the line. The cable should be terminated at each end with a 120 ohm (0.25 Watt min.) resistor.

A total maximum length of 3900 feet (1200 metres) is allowed for the RS485 network. A maximum of 32 electrical nodes can be connected, including the controller.

The address of each Integra 1000/1540 can be set to any value between 1 and 247. Broadcast mode (address 0) is not supported.

The maximum latency time of an Integra 1000/1540 is 150ms i.e. this is the amount of time that can pass before the first response character is output. The supervisory programme must allow this period of time to elapse before assuming that the Integra is not going to respond.

The data format in RTU mode is:

Coding System:	8-bit per byte
Data Format:	4 bytes (2 registers) per parameter. Floating point format (to IEEE 754) Most significant register first (Default). The default may be changed if required - See Holding Register "Register Order" parameter.
Error Check Field:	2 byte Cyclical Redundancy Check (CRC)
Framing:	1 start bit 8 data bits, least significant bit sent first 1 bit for even/odd parity or no parity 1 stop bit if parity is used; 1 or 2 bits if no parity

Data Transmission speed is selectable between 2400, 4800, 9600 and 19200 baud.

Input Registers

Input registers are used to indicate the present values of the measured and calculated electrical quantities.

Each parameter is held in two consecutive 16 bit registers. The following table details the 3X register address, and the values of the address bytes within the message. A tick (÷) in the column indicates that the parameter is valid for the particular wiring system. Any parameter with a cross (X) will return the value Zero (0000h). Some parameters are only available on the Integra 1540, as shown in the table below..

Each parameter is held in the 3X registers. Modbus Function Code 04 is used to access all parameters.

e.g. to request	Volts 1	Start address	= 00
	No of registers		= 02
	Volts 2	Start address	= 02
	No of registers		= 02

Each request for data must be restricted to 40 parameters or less. Exceeding the 40 parameter limit will cause a Modbus exception code to be returned.

Register	Parameter Number	Parameter	Modbus Start Address Hex		3 Ø 4 wire	3 Ø 3 wire	1 Ø 3 wire	1 Ø 2 wire
			High Byte	Low Byte				
30001	1	Volts 1 (L1 – N 4W or L1 – L2 3W)	00	00	✓	✓	✓	✓
30003	2	Volts 2 (L2 – N 4W or L2 – L3 3W)	00	02	✓	✓	✓	X
30005	3	Volts 3 (L3 – N 4W or L3 – L1 3W)	00	04	✓	✓	X	X
30007	4	Current 1	00	06	✓	✓	✓	✓
30009	5	Current 2	00	08	✓	✓	✓	X
30011	6	Current 3	00	0A	✓	✓	X	X
30013	7	Watts Phase 1 - Integra 1540 only	00	0C	✓	X	✓	✓
30015	8	Watts Phase 2 - Integra 1540 only	00	0E	✓	X	✓	X
30017	9	Watts Phase 3 - Integra 1540 only	00	10	✓	X	X	X
30019	10	VA Phase 1 - Integra 1540 only	00	12	✓	X	✓	✓
30021	11	VA Phase 2 - Integra 1540 only	00	14	✓	X	✓	X
30023	12	VA Phase 3 - Integra 1540 only	00	16	✓	X	X	X
30025	13	var Phase 1 - Integra 1540 only	00	18	✓	X	✓	✓
30027	14	var Phase 2 - Integra 1540 only	00	1A	✓	X	✓	X
30029	15	var Phase 3 - Integra 1540 only	00	1C	✓	X	X	X
30031	16	Power Factor Phase 1 - Integra 1540 only	00	1E	✓	X	✓	✓
30033	17	Power Factor Phase 2 - Integra 1540 only	00	20	✓	X	✓	X
30035	18	Power Factor Phase 3 - Integra 1540 only	00	22	✓	X	X	X
30037	19	Phase Angle Phase 1 - Integra 1540 only	00	24	✓	X	✓	✓
30039	20	Phase Angle Phase 2 - Integra 1540 only	00	26	✓	X	✓	X
30041	21	Phase Angle Phase 3 - Integra 1540 only	00	28	✓	X	X	X
30043	22	Volts Ave	00	2A	✓	✓	✓	✓
30047	24	Current Ave	00	2E	✓	✓	✓	✓
30049	25	Current Sum - Integra 1540 only	00	30	✓	✓	✓	✓
30053	27	Watts Sum	00	34	✓	✓	✓	✓
30057	29	VA Sum	00	38	✓	✓	✓	✓
30061	31	var Sum	00	3C	✓	✓	✓	✓
30063	32	Power Factor Ave	00	3E	✓	✓	✓	✓
30067	34	Average Phase Angle - Integra 1540 only	00	42	✓	✓	✓	✓
30071	36	Frequency	00	46	✓	✓	✓	✓
30073	37	Wh Import	00	48	✓	✓	✓	✓
30077	39	varh Import	00	4C	✓	✓	✓	✓
30085	43	W Demand Import	00	54	✓	✓	✓	✓
30087	44	W Max. Demand Import	00	56	✓	✓	✓	✓
30105	53	A Demand	00	68	✓	✓	✓	✓
30107	54	A Max. Demand	00	6A	✓	✓	✓	✓
30201	101	V L1-L2 (calculated)	00	C8	✓	X	✓	X
30203	102	V L2-L3 (calculated)	00	CA	✓	X	X	X
30205	103	V L3-L1 (calculated)	00	CC	✓	X	X	X
30207	104	Average Line to Line Volts	00	CE	✓	X	✓	X
30225	113	Neutral Current	00	E0	✓	X	✓	✓
30235	118	THD Volts 1 - Integra 1540 only	00	EA	✓	✓	✓	✓
30237	119	THD Volts 2 - Integra 1540 only	00	EC	✓	✓	✓	X
30239	120	THD Volts 3 - Integra 1540 only	00	EE	✓	✓	X	X
30241	121	THD Current 1 - Integra 1540 only	00	F0	✓	✓	✓	✓
30243	122	THD Current 2 - Integra 1540 only	00	F2	✓	✓	✓	X
30245	123	THD Current 3 - Integra 1540 only	00	F4	✓	✓	X	X
30249	125	THD Voltage Mean - Integra 1540 only	00	F8	✓	✓	✓	✓
30251	126	THD Current Mean - Integra 1540 only	00	FA	✓	✓	✓	✓
30255	128	Power Factor (+Ind/-Cap)	00	FE	✓	✓	✓	✓

Modbus Holding Registers and Integra set up

Holding registers are used to store and display instrument configuration settings. All holding registers not listed in the table below should be considered as reserved for manufacturer use and no attempt should be made to modify their values.

The demand parameters may be viewed or changed using the Modbus protocol. Each parameter is held in the 4X registers. Modbus Function Code 03 is used to read the parameter and Function Code 16 is used to write.

Register	Parameter	Parameter Number	Modbus Start Address Hex		Valid range	Mode
			High Byte	Low Byte		
40001	1	Demand Time	00	00	0 only	r/w
40003	2	Demand Period	00	02	8,15,20,30 minutes.	r/w
40007	4	System Voltage	00	06	1V - 400kV	r/wp
40009	5	System Current	00	08	1-9999 A	r/wp
40011	6	System Type	00	0A		ro
40013	7	Relay Pulse Width	00	0C	3,5,10 (x20mS)	r/w
40015	8	Energy Reset	00	0E	0 only	wo
40023	12	Pulse Divisor	00	16	1,10,100,1000	r/w
40025	13	Password	00	18	0000-9999	r/w
40037	19	System Power	00	24		r/o
40041	21	Register Order	00	28	2141.0 only	wo
40299	150	Secondary Volts	01	2A	Min Vin-Max Vin	r/wp

r/w = read/write r/wp = read and write with password clearance ro = read only wo = write only

Password Settings marked r/wp require the instrument password to have been entered into the Password register before changes will be accepted. Once the instrument configuration has been modified, the password should be written to the password register again to protect the configuration from unauthorised or accidental change. Power cycling also restores protection. Reading the Password register returns 1 if the instrument is unprotected and 0 if it is protected from changes.

Demand Time is used to reset the demand period. A value of zero must be written to this register to accomplish this. Writing any other value will cause an error to be returned. Reading this register after instrument restart or resetting demand period gives the number of minutes of demand data up to a maximum of the demand period setting. For example, with 15 minute demand period, from reset the value will increment from zero every minute until it reaches 15. It will remain at this value until a subsequent reset occurs.

Demand Period The value written must be one of the following 8,15, 20 or 30 (minutes), otherwise an error will be returned.

System Type The System type address will display '1' for single phase 2 wire, '2' for 3 Phase 3 Wire, '3' for 3 Phase 4 Wire or 4 for single phase 3 wire.

Relay Pulse Width is the width of the relay pulse in multiples of 20 ms. However, only values of 3 (60 ms), 5 (100 ms) or 10 (200 ms) are supported. Writing any other value will cause an error to be returned.

Reset Energy is used to reset the Energy readings. A value of zero must be written to this register to accomplish this. Writing any other value will cause an error to be returned.

Pulse Rate Divisor, supports only values of 1,10,100 or 1000. Writing any other value will cause an error to be returned.

System Power, is the maximum system power based on the values of system type, system volts and system current.

Register Order, the instrument can receive or send floating-point numbers in normal or reversed register order. In normal mode, the two registers that make up a floating point number are sent most significant bytes first. In reversed register mode, the two registers that make up a floating point number are sent least significant bytes first. To set the mode, write the value '2141.0' into this register - the instrument will detect the order used to send this value and set that order for all Modbus transactions involving floating point numbers.

Secondary Volts indicates the voltage on the VT secondary when the voltage on the Primary is equal to the value of System Volts . The value of this register can be set to between the minimum and maximum instrument input voltage.

6.3 RS485 Implementation of Johnson Controls Metasys

These notes explain Metasys and Crompton Instruments Integra 1000/1540 integration. Use these notes with the Metasys Technical Manual, which provides information on installing and commissioning Metasys N2 Vendor devices.

Application details

The Integra 1000/1540 is a N2 Vendor device that connects directly with the Metasys N2 Bus. This implementation assigns 33 key electrical parameters to ADF points, each with override capability.

Components requirements

- Integra 1000/1540 with RS485 option.
- N2 Bus cable.

Metasys release requirements

- Metasys OWS software release 7.0 or higher.
- Metasys NCM311. NCM360.

Support for Metasys Integration

Johnson Control Systems
System House, Randalls Research Park,
Randalls Way, Leatherhead,
Surrey, KT22 7TS
England

Support for Crompton Integra operation

This is available via local sales and service centre.

Design considerations

When integrating the Crompton equipment into a Metasys Network, keep the following considerations in mind.

- Make sure all Crompton equipment is set up, started and running properly before attempting to integrate with the Metasys Network.
- A maximum of 32 devices can be connected to any one NCM N2 Bus.

Vendor Address	1-247 (Limited by co-resident Modbus protocol)
Port Set-up	
Baud Rate	9600
Duplex	Full
Word Length	8
Stop Bits	1
Parity	None
Interface	RS485

METASYS N2 application

Integra 1560/1580 Point Mapping table

Address	Parameter Description	Units
1	Voltage 1	Volts
2	Voltage 2	Volts
3	Voltage 3	Volts
4	Current 1	Amps
5	Current 2	Amps
6	Current 3	Amps
7	Voltage average	Volts
8	Current average	Amps
9	Power (Watts) Sum	kW
10	VA Sum	kVA
11	var Sum	kvar
12	Power Factor average	
13	Frequency	Hz
14	Active Energy (Import)	kWh
15	Reactive Energy (Import)	kvarh
16	Watts Demand (Import)	kW
17	Maximum Watts Demand (Import)	kW
18	Amps Demand	Amps
19	Maximum Amps Demand	Amps
20	Voltage L1-L2 (calculated)	Volts
21	Voltage L2-L3 (calculated)	Volts
22	Voltage L3-L1 (calculated)	Volts
23	Neutral Current	Amps
24	Active Energy (Import)	GWh
25	Reactive Energy (Import)	Gvarh

The following parameters are available only on the Integra 1540

26	THD V1	%
27	THD V2	%
28	THD V3	%
29	THD I1	%
30	THD I2	%
31	THD I3	%
32	THD Vmean	%
33	THD Imean	%

7 Maintenance

Warning

- **During normal operation, voltages hazardous to life may be present at some of the terminals of this unit. Installation and servicing should be performed only by qualified, properly trained personnel' abiding by local regulations. Ensure all supplies are de-energised before attempting connection or other procedures.**
- **It is recommended adjustments be made with the supplies de-energised, but if this is not possible, then extreme caution should be exercised.**
- **Terminals should not be user accessible after installation and external installation provisions must be sufficient to prevent hazards under fault conditions.**
- **This unit is not intended to function as part of a system providing the sole means of fault protection - good engineering practice dictates that any critical function be protected by at least two independent and diverse means.**

In normal use, little maintenance is needed. As appropriate for service conditions, isolate electrical power, inspect the unit and remove any dust or other foreign material present. Periodically check all connections for freedom from corrosion and screw tightness, particularly if vibration is present.

The front of the case should be wiped with a dry cloth only. Use minimal pressure, especially over the viewing window area. If necessary wipe the rear case with a dry cloth. If a cleaning agent is necessary, isopropyl alcohol is the only recommended agent and should be used sparingly. Water should not be used. If the rear case exterior or terminals should accidentally be contaminated with water, the unit must be thoroughly dried before further service. Should it be suspected that water might have entered the unit, factory inspection and refurbishment is recommended.

In the unlikely event of a repair being necessary, it is recommended that the unit be returned to the factory or nearest Crompton service centre.

tyco
Electronics

Energy Division

Tyco Electronics UK Limited
Crompton Instruments
Freebournes Road, Witham,
Essex, CM8 3AH, UK

Tel.: +44 1376 509 509
Fax: +44 1376 509 511

DECLARATION OF CONFORMITY

Manufacturer's Name: Tyco Electronics UK Limited - Crompton Instruments
Manufacturer's Address: Freebournes Road, Witham, Essex, CM8 3AH, UK

declares that the products:
Product Names: Integra 1540 series Multifunction Digital Metering System
Model Numbers: INT-0240, INT-0340, INT-0440, INT-0640, INT-0740, INT-1540

conforms to the following standards:

LVD:
BS EN 61010-1 : 1993 Plus Amendment 2 (July 1995)
Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

EMC:

BS EN 61326: 1998A1 Emissions standard for Measurement Control and Laboratory Equipment, Class B

BS EN 61326: 1998A1 Immunity standard for Measurement Control and Laboratory Equipment, Annex A

Supplementary Information:
The product complies with the requirements of the following EU directives and carries CE marking accordingly

- **European Low Voltage Directive 73/23/EEC** amended by **93/69/EEC** by the standards route to compliance.
- **EMC Directive 89/336/EEC**, amended by **93/68/EEC**, by the standards route to compliance.

Signature of authorised person.

N F Dudley
R&D Manager

Dated: 27 March 2003

Crompton INSTRUMENTS

FM 21540

Registered Office: Faraday Road, Dorcan, Swindon, Wiltshire, SN3 5HH, UK
Registered No. 550926
VAT No. GB 681 471 425

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DECLARATION OF CONFORMITY

Manufacturer's Name: Tyco Electronics UK Limited - Crompton Instruments
Manufacturer's Address: Freebournes Road, Witham, Essex, CM8 3AH, UK

declares that the products:
Product Names: Integra 1560 Transducer and display
Model Numbers: INT-1561, INT-1562, INT-1563, INT-1564, INT-1581, INT-1582, INT1583, INT-1584, DIS-0240, DIS-0340, DIS-0640, DIS-0740, DIS-1540

conforms to the following standards:

LVD:

BS EN 61010-1 : 1993 Plus Amendment 2 (July 1995)
Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

EMC:

BS EN 61326: 1998A1 Emissions standard for Measurement Control and Laboratory Equipment, Class A

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Signature of authorised person.

N F Dudley
R&D Manager

Dated: 30 April 2002

Crompton INSTRUMENTS

FM 21540

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Swindon, Wiltshire, SN3 5HH, UK
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VAT No. GB 681 471 425

Crompton INSTRUMENTS

Notes

The Information contained in these installation instructions is for use only by installers trained to make electrical power installations and is intended to describe the correct method of installation for this product. However, Tyco Electronics has no control over the field conditions which influence product installation.
It is the user's responsibility to determine the suitability of the installation method in the user's field conditions. Tyco Electronics' only obligations are those in Tyco Electronics' standard Conditions of Sale for this product and in no case will Tyco Electronics be liable for any other incidental, indirect or consequential damages arising from the use or misuse of the products. Crompton is a trade mark.

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